

ACKNOWLEDGEMENTS
FOURTH ANNUAL REPORT

to

THE COMMITTEE ON THE RELATION OF ELECTRICITY TO AGRICULTURE

Through the splendid cooperation of the Project Directors
and Field Engineers, we are able to present at this meeting a complete
summary of the investigation work under way on the various
State Projects.

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THE ASSISTANT DIRECTOR

JUNE 20-21, 1927

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Professor Edwin Curtis

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Unless otherwise indicated, credit for the data here presented belongs to the following men:

ALABAMA

Professor M. L. Nichols
E. C. Easter

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IDaho	Professor M. R. Lewis	NEBRASKA	Professor E. E. Probst
	Robert Beresford		
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KANSAS	Professor H. B. Walker	OKLAHOMA	Professor Edwin Kutz
	H. S. Hirtich		

ALL COOKING WITH ELECTRIC RANGE

3

No. for family		Max. for family		Average	
STATE	No.	Ex. hrs.	Ex. hrs.	No. of families	av. no. in family
OREGON			TEXAS		
Professor W. J. Gilmore			J. E. Waggoner		
Professor Geo. W. Kable					
ALABAMA	2	165	VIRGINIA	2	4
ILLINOIS			Professor Chas. E. Seitz		3.9
Professor John M. McKee	4	120	James A. Waller, Jr.		4
MINNESOTA				1	
SOUTH CAROLINA	6	260	WASHINGTON	2	6
Professor J. T. McAlister		327	Professor L. J. Smith		9.5
Average for South			Harry L. Garver		
SOUTH DAKOTA			WISCONSIN		
Professor Ralph L. Patty			Professor F. W. Duffee		
			E. R. Meacham		
			W. C. Krueger		

MONTHLY KN. FEE. 1

Wisconsin

Wisconsin

Wisconsin

Number in family

12

3

Month	225	200
January	225	200
February	221	120
March	191	115
April	380	128
May	456	155
June	482	164
July	461	145
August	430	149
September	407	143
October	124	180
November	120	72
December	212	118
TOTAL	3961	1922

COMBINATION ELECTRIC RANGE OR ITS EQUIVALENT

Data given are per family

STATE	No. in family	Months used	Kn. hrs. month	Kn. hrs. month	Av. per month for time used	Total per year
			Ex. hrs. month	Ex. hrs. month	Ex. hrs. month	Ex. hrs. month
Indiana	1	12	204	204	204	2448
Kansas	6	12	240	240	240	2880
Minnesota	6	12	485	485	485	5820
Minnesota	7	12	139	139	139	1668
Minnesota	12	12	74	74	74	888
Minnesota	3	12	87	87	87	1044
Minnesota	12	7	125	125	125	1500
New Hampshire	5	12	102	102	102	1224
New Hampshire	6	12	171	171	171	2052

This gives an average of 16 Kn. hrs. per person per month - about one-half as much as when an electric range is used for all cooking.

OREGON

Professor W. J. Gilmore
Professor Geo. W. Kable

PENNSYLVANIA

John M. McKee

SOUTH CAROLINA

Professor J. T. McAlister

SOUTH DAKOTA

Professor Ralph L. Pety

TEXAS

J. E. Wegener

VIRGINIA

Professor Chas. E. Seife
James A. Waller, Jr.

WASHINGTON

Professor L. J. Smith
Harry L. Garver

WISCONSIN

Professor F. W. Duffee
E. R. Moscham
W. C. Krueger

C O O K I N G

ALL COOKING WITH ELECTRIC RANGE

STATE	Min. for family		Max. for family		Average		
	Kw. hrs	No.	Kw. hrs.	No.	Kw. hrs.	No. of	Av. no.
	per month	in	per mo.	in	per mo.	families	in
	av. for yr.	family	Av. for yr.	family	Av. for yr.		family
Alabama	80	2	145	6	125	2	4
Illinois					185	8	5.9
Kansas	135	4	190	4	163	2	4
Minnesota					187	1	
New Hampshire	196	6	260	6	228*	2	6
Wisconsin	143	6	327	13	235	2	9.5
* Average for six months							
Average kw. hrs. per person per month							31.3

MONTHLY KW. HRS. PER FAMILY

Months	Wisconsin		Minnesota
	Number in family		
	13	6	
January	225	209	191
February	211	120	211
March	181	115	200
April	380	128	166
May	455	155	195
June	482	184	163
July	461	145	177
August	450	149	180
September	487	146	184
October	124	180	236
November	130	72	204
December	315	119	141
TOTAL	3901	1722	2248

COMBINATION ELECTRIC RANGE OR ITS EQUIVALENT

Data given are per family

STATE	No. in family	Months used	Min.	Max.	Av. per month	Total per year
			month	month	for time used	
			Kw.hrs.	Kw.hrs.	Kw. hrs.	Kw. hrs.
Indiana	4	12		204	176	2112
Kansas	4	12	20	140	73	876
Minnesota		8	1	265	108	864
Minnesota		7	23	139	82	571
Minnesota		12	16	73	48	581
Minnesota		5	11	83	40	200
Minnesota		12	7	134	63	751
New Hampshire	5	12	4	102	26	312
New Hampshire	6	12	171	429	232	3384

This gives an average of 16 Kw. hrs. per person per month - about one-half as much as when an electric range is used for all cooking.

ALL COOKING WITH ELECTRIC RANGE

STATE	Min. for family Kw. hrs. per month av. for yr. family	Max. for family Kw. hrs. per month av. for yr. family	Average Kw. hrs. per month av. for yr.	No. of families in	Av. no. family
Alabama	80	145	125	2	4
Illinois	125	190	185	8	5.9
Kansas	125	190	185	2	4
Minnesota	125	190	185	1	8
New Hampshire	125	250	228*	2	9.5
Wisconsin	143	327	235	2	
* Average for six months					
Average Kw. hrs. per person per month 31.3					

MONTHLY KW. HRS. PER FAMILY

Months	Wisconsin	Wisconsin	Minnesota
Number in family	12	8	
January	225	209	191
February	211	180	211
March	181	115	200
April	280	128	168
May	455	125	195
June	482	184	193
July	461	145	177
August	450	149	180
September	487	146	184
October	124	180	228
November	120	72	204
December	315	119	141
TOTAL	3901	1722	2248

COMBINATION ELECTRIC RANGE OR ITS EQUIVALENT

Data given are per family

STATE	No. in family	Months used	Min. month Kw. hrs.	Max. month Kw. hrs.	Av. per month for time used Kw. hrs.	Total per year Kw. hrs.
Indiana	4	12	204	178	212	2548
Kansas	4	12	20	140	78	948
Minnesota	8	1	255	108	684	
Minnesota	7	25	139	82	871	
Minnesota	12	16	73	48	881	
Minnesota	11	83	40	40	200	
Minnesota	7	124	62	62	781	
Minnesota	4	102	28	28	312	
New Hampshire	141	429	232	232	3384	

This gives an average of 16 Kw. hrs. per person per month - about one-half as much as when an electric range is used for all cooking.

(a) It is practically impossible to anticipate what the addition of a certain number of ranges will mean in the way of additional load on a rural line. However, present available data would seem to indicate that 100 Kw. hrs. per range for the summer months and 75 Kw. hrs. for winter can be safely assumed in the Middle West. However, the consumption has a tendency to increase until all the cooking is done electrically. In the far West, the figures should be raised about 20%.

(b) Due to canning and harvesting help, there is frequently an individual late summer peak 125% to 140% above the average. Where there are a large number of ranges on the line, the average peak is much lower, and is about the same for the whole summer. In the South there is apparently a 10% peak during the winter and no summer peak of any consequence.

Electric Range

In the average family where all the cooking is done electrically, the average monthly energy consumption will be 31.3 Kw. hrs. per person per month. In the South this consumption will be apparently about 20% lower, probably due to the smaller amount of baking done.

Combination Range

The monthly energy consumption of the combination range will be about half that of the electric range or 16 Kw. hrs. per person per month. Where the range is used for baking only, 20 to 25 kw. hrs. per month will be used

Important Factors in Determining the Energy Consumption of an Electric Range

(a) Probably the most important factor in determining the energy consumption is whether it is used for heating the kitchen, that is, as a combination range. However, there seems to be a tendency to use the range for a larger and larger percentage of the cooking until it is all done in this way.

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(a) Probably the most important factor in determining the energy consumption is whether it is used for heating the kitchen, that is, as a combination range. However, there seems to be a tendency to use the range for a larger and larger percentage of the cooking until it is all done in this way.

(b) Very seldom is any considerable amount of water heated on the range, but where the water for all purposes is so heated the energy consumption of the range is at least doubled.

(c) As a general rule the amount of electrical energy per person required for cooking will decrease as the size of the family increases. In a family of two it will be 40 or 50 Kw. hrs. per person per month. This may decrease to 25 Kw. hrs. per person per month in a family of ten.

(d) According to some tests made by the Malleable Iron Range Company, the use of oven cooking methods as far as practicable, as compared to ordinary open pan methods, will decrease the energy consumption about 30%. In the light of general observations this figure does not appear to be unreasonable.

(e) The use of a steam pressure cooker will probably save as much energy as oven cooking methods, but in the ordinary family not over 30% can be saved through their combined use---slightly more than where one alone is used. Insulation should be used on the cooker.

(f) The use of a fireless cooker--really a small electric oven--whether as an integral part of the stove or as an individual cooking unit, will save considerable energy where there is not enough food to fill the larger oven, as it takes considerable energy to bring a large oven up to temperature. For this reason the oven should be no larger than necessary. It has in some cases taken about one-half as much energy to do a small cooking job with a fireless cooker as with the oven.

(g) It has been estimated that automatic temperature control will lower the energy consumption of a range, as compared to one without, about 25%. Furthermore, it will remove many of the uncertainties of baking.

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(e) The use of a steam pressure cooker will probably save as much energy as oven cooking methods, but in the ordinary family not over 50% can be saved through their combined use---slightly more than where one alone is used. Insulation should be used on the cooker.

(f) The use of a fireless cooker---really a small electric oven---whether as an integral part of the stove or as an individual cooking unit, will save considerable energy where there is not enough food to fill the larger oven, as it takes considerable energy to bring a large oven up to temperature. For this reason the oven should be no larger than necessary. It has in some cases taken about one-half as much energy to do a small cooking job with a fireless cooker as with the oven.

(g) It has been estimated that automatic temperature control will lower the energy consumption of a range, as compared to one without, about 25%. Furthermore, it will remove many of the uncertainties of baking.

It would seem safe to compare 185 Kw. hrs. per month in a family of 6 to .5 ton of coal, 33 gals. of kerosene, 20 gals. of gasoline, and close to .5 cord of hard or soft wood, for cooking.

Conclusions

While the homemaker very frequently uses the range only during the summer, when it is first installed, generally she makes continually greater use of it as she becomes acquainted with its convenience until all the cooking and baking are done electrically. In fact, the range represents one of the power companies' largest potential loads and one of the homemaker's greatest conveniences.

The first cost is one of the greatest obstacles to the more general use of the electric range. However, very gratifying progress has been made along this line during the past year. For the use of an electric range to be practical on the farm a 3-cent rate for energy would seem to be essential.

FIRELESS AND STEAM PRESSURE COOKERS

Fireless Cookers

Fireless cookers are very popular where they are large enough so that the homemaker does not have to cook the meals in relays. They are really small electric ovens and are usually put away with the advent of a range. In one home in Wisconsin a cooker consumed 26 kw. hrs. per month. It was a great help to the farmer's wife.

The small fireless cookers which are an integral part of some electric ranges can well be used when they will hold the materials to be cooked. This is quite important from the standpoint of energy consumption as obviously the pre-heating required is much lower, in fact cutting the cooking cost of foods in small quantities almost 50% as compared to a standard oven.

Steam pressure cookers offer homemakers real opportunities to cook

more economically as the higher temperatures attainable materially shorten the cooking process. Furthermore, because of this high temperature they make difficult canning operations relatively easy. With a pressure cooker of adequate size the farmer's wife can do her cooking with about 25% per cent less energy as compared to open cooking methods. An insulated pressure cooker should be still more practical.

INDIVIDUAL COOKING UNITS

Individual cooking units such as chafin dishes, frying pans, grills, hot plates, percolators, toasters, waffle irons, table stoves, corn poppers, small ovens, etc. are all socket devices and are quite widely used. One or more of these devices are generally in the farm home with electric service and even though their use is limited they represent quite a convenience. One or more hot plates and an oven can be used in the place of an electric range and at materially less cost. They can be purchased one at a time at slight cost and meanwhile the farmer's wife has had many of the advantages afforded by the electric range. The waste of most of the devices is around 500 to 600 and usually not over 5 to 10 Kw. hrs. per month are used by them. However, when they are used to do a large amount of cooking, the current consumption will be higher.

KITCHEN VENTILATING FAN

Ventilating fans are very effective in removing cooking odors, steam, and gases from the kitchen, being especially helpful on washdays. One fan will keep the air clear in the average sized kitchen. These fans are inexpensive and easy to install. They are so mounted that the window can still be opened and closed without difficulty. The energy consumption is negligible. Energy consumption figures and other data will be available on a very satisfactory installation in New Hampshire, at an early date.

L A U N D R Y

Washing Machine

<u>State</u>	<u>Kw. hrs. Monthly range</u>	<u>Kw. hrs. av. Per family Per month</u>	<u>Av. number in Family</u>	<u>Number of Families</u>
Illinois	1.0 -2.7	1.95	6.2	7
Indiana	2.25-2.50	2.00	4.5	2
Kansas	2.16-3.15	2.64	4.3	3
New Hampshire	1.0 -5.7	2.60	4.	6
Virginia	1.9 -5.10	3.70		4

The energy consumption for the newer machines of the dolly or inverted dolly type is around 2 kw. hrs. per family per month, or around 1/3 Kw. hr. per person per month. Some other types will have slightly higher consumptions, and with the older types the consumption will be about double that given above. It is evident that the consumption at most is negligible.

It ordinarily takes around 1.5 Kw. hrs. to wash 100 lbs. of clothes or around .55 Kw. hrs. for an average wash of 35 lbs.

On account of the labor which it saves, the washing machine is generally one of the first pieces of electric household equipment purchased.

One of the chief deterrents to the sale of washing machines is high first cost.

When purchasing a machine, the housewife should remember that different machines have different characteristics. Some, such as the dolly and inverted dolly types, do fast work; others, such as the cylinder type, are slower but easier on the clothes.

General Considerations

The advent of public laundries which satisfactorily handle the family wash (such as "wet wash") at a very nominal charge, has materially altered the domestic washer situation in cities and towns. There are indications that this system can compete with the home laundry. It has been reported as spreading to the country.

State	Kw. hrs. Monthly range	Kw. hrs. av. Per family Per month	Av. number in Family	Number of Families
Illinois	1.0-2.7	1.95	4.2	7
Indiana	2.25-2.50	2.00	4.5	2
Kansas	2.15-2.15	2.24	4.3	2
New Hampshire	1.0-2.7	2.80	4.	2
Virginia	1.9-2.10	2.70		4

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Electric Ironing Machines

State	Kw. hrs.		Number in Family	Kw. hrs.	
	Per Family Monthly Range	Per Month Average		Per Person Variations	Per Month Average
Illinois	2.25- 9.8	6.4	7		
Indiana	7.17-11.7	9.43	4-5	1.8	1.8
Iowa	4 - 7	5	4	1-1.75	1.25
Kansas	7.92	7.92	4	1.98	1.98
New Hampshire	7.2 -18.3	12.7	5-6	1.43-3.3	2.36

An electric ironing machine, when once its use is mastered, will enable the homemaker to do her ironing in from $1/4$ to $1/3$ of the time that would be required with a hand iron. Furthermore, the work will be done much more easily and pleasantly.

Energy Consumption

The energy consumption of an ironer, when its use is thoroughly mastered, will probably be about the same as for the hand iron or, say 6 or 7 Kw. hrs. per month in a family of 5. When the operator becomes efficient in the use of the machine the monthly consumption can be reduced to about 1.25 Kw. hrs. per person. However, at first the consumption will probably be twice as high.

After the use of the ironer is mastered the hand iron will seldom be touched as practically everything can be ironed by a skillful operator. Obviously it is much easier to iron clothes with simple lines whether a hand iron or a machine is used.

Electric Hand Irons

State	Kw. Hrs.		Number in Family	Kw. hrs.	
	Per Family Monthly Range	Per Month Average		Per Person Range	Per Month Average
Iowa	1.5 -5.25	2.85	4-3	1.3 - .31	.70
Kansas	5.85-6.68	6.0	4-5	1.17-1.33	1.25
New Hampshire	5.8 -8.6	7.3	6	1.17-1.6	1.37

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State	Range	Average	Number in Family	Variations	Average
Illinois	2.25-6.8	6.4	7	1.8	1.8
Indiana	7.17-11.7	9.43	4-5	1-1.75	1.25
Iowa	4 - 7	5	4	1.98	1.98
Kansas	7.92	7.92	4	1.43-3.3	2.38
New Hampshire	7.2-18.3	12.7	5-6		

An electric ironing machine, when once its use is mastered, will enable the homemaker to do her ironing in from $1\frac{1}{4}$ to $1\frac{1}{3}$ of the time that would be required with a hand iron. Furthermore, the work will be done much more easily and pleasantly.

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Electric Hand Irons

State	Range	Average	Number in Family	Range	Average
Iowa	1.6-5.25	2.85	4-5	1.3 - .31	.70
Kansas	5.85-6.88	6.0	4-5	1.17-1.33	1.25
New Hampshire	5.8-6.8	7.3	6	1.17-1.6	1.37

Practically every farmer's wife with electric service has an electric iron. On a numerical basis it is the most popular electrical device on the farm.

In some tests in Wisconsin it was found that the ironing could be done in almost one-third less time (32.8%) with an electric iron than with sad irons. In addition, it saved a multitude of trips to the stove. Since according to some work done on the Ohio project it requires on the average about nine hours per month to do the ironing with sad irons, for families of five people, an electric hand iron will save the homemaker about three hours per month.

Energy Consumption

The energy consumption of the electric hand iron in the average family is around 6 Kw. hrs. per month or close to 1-1/4 Kw. hrs. per person per month. However, the individual variations are quite large, running on an individual basis from .31 to 1.6 Kw. hrs. per month per person.

HOUSEHOLD REFRIGERATION

<u>State</u>	<u>Kw. hrs. per Month Yearly av.</u>	<u>Kw. hrs. per Month Summer</u>	<u>Kw. hrs. per Month Winter</u>	<u>Kw. hrs. Summer Max.</u>	<u>Number of Boxes</u>
Alabama	50.				2
Illinois	41.9	56.1	27.7	80.3	10
Indiana	44.8				2
Iowa	82	118	56.	138.	3
Kansas	68.5			106.6	4
Minnesota	36.0				3
Nebraska	67.5	80		80	2
New Hampshire	35.3	50	20.	62.5	6
South Dakota	40.3			80	8
Wisconsin	25			67	1
Average	<u>48.9</u>			<u>89.7</u>	<u>41</u>

The electric refrigerator is one of the most highly esteemed of the higher priced electrical devices on the farm. Its high first cost is, of course, a strong deterrent to its wider use. In this connection it is most gratifying to be able to report material reductions in the prices of this equipment during the past year.

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The energy consumption of the electric hand iron in the average family is around 6 Kw. hrs. per month or close to $1\frac{1}{4}$ Kw. hrs. per person per month. However, the individual variations are quite large, running on an individual basis from .31 to 1.6 Kw. hrs. per month per person.

HOUSEHOLD REFRIGERATION

State	Kw. hrs. per Month Yearly av.	Kw. hrs. per Month Summer	Kw. hrs. per Month Winter	Kw. hrs. Summer Max.	Number of Boxes
Alabama	50.9				2
Illinois	41.9	36.1	27.7	80.3	10
Indiana	44.8				2
Iowa	32	118	32	138.6	2
Kansas	38.5			106.6	4
Minnesota	36.0				3
Nebraska	37.5	30		80	2
New Hampshire	35.2	30	20	32.5	6
South Dakota	40.2			80	8
Wisconsin	25			37	1
Average	42.9			89.7	41

The electric refrigerator is one of the most highly esteemed of the higher priced electrical devices on the farm. Its high first cost is, of course, a strong deterrent to its wider use. In this connection it is most gratifying to be able to report material reductions in the prices of this equipment during the past year.

The monthly average consumption of the 41 refrigerators on which test data are available is 48.9 Kw. hrs. but the data from Renner, South Dakota, are probably quite representative of what can be expected for the first year or two from small standard outfits as the boxes were purchased by the farmers and the energy was not in any case donated for experimental purposes. The average consumption was 40.3 Kw. hrs. per month for 1926 and the average peak was about 80 Kw. hrs., being about the same for July, August, and September.

If the standard boxes were used the year around instead of being left idle for from 3 to 5 months in the cold part of the year, as was done at Renner, the average consumption would be around 50 Kw. hrs. per month. The consumption for the 6 months from November to April inclusive was low, on the Renner line.

If the large size box (about 12 cu. ft.) were used the year around and kept in a warm room, the consumption would be around 65 Kw. hrs. per month, giving a summer peak of about 95 Kw. hrs.

Where considerable frozen dessert is served the consumption may be increased about 20%.

Conclusions

There seems to be a tendency for the refrigerator to be used the year around as the owner feels he can afford it. Obviously the storage of food at uniform temperatures thruout the year is much to be preferred from the stand-points of convenience and food economy.

If the labor of the farmer and his wife in caring for the ice box is added to cost of ice (both at farm prices, the ice including labor of harvesting, etc.) the electric refrigerator is more economical than older methods, disregarding entirely the many well known advantages and conveniences of using the latter, such as better food preservation.

There seems to be a tendency on the part of the farmer to demand larger boxes so that he can store such things as a dressed hog, a quarter of beef, or a

The monthly average consumption of the 41 refrigerators on which test data are available is 46.9 Kw. hrs. but the data from Renner, South Dakota, are probably quite representative of what can be expected for the first year or two from small standard outfits as the boxes were purchased by the farmers and the energy was not in any case donated for experimental purposes. The average consumption was 40.3 Kw. hrs. per month for 1926 and the average peak was about 80 Kw. hrs., being about the same for July, August, and September.

If the standard boxes were used the year around instead of being left idle for from 3 to 6 months in the cold part of the year, as was done at Renner, the average consumption would be around 50 Kw. hrs. per month. The consumption for the 6 months from November to April inclusive was low, on the Renner line. If the large also box (about 15 cu. ft.) were used the year around and kept in a warm room, the consumption would be around 66 Kw. hrs. per month, giving a summer peak of about 96 Kw. hrs.

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creased about 20%.

Conclusions

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If the labor of the farmer and his wife in caring for the ice box is added to cost of ice, both at farm prices, the ice including labor of harvesting, etc., the electric refrigerator is more economical than other methods, disregarding entirely the many well known advantages and conveniences of using the latter such as better food preservation.

There seems to be a tendency on the part of the farmer to demand larger boxes so that he can store such things as a dressed hog, a quarter of beef, or a

5-gallon can of cream. The homemade box with inside dimensions of 4'x4'x8' that was made in Alabama of 3 layers of Celotex and a 2" air space may be an answer to this demand as it was inexpensive and had an average monthly energy consumption of only 50 Kw. hrs. If such a box as was used in Alabama becomes popular it will undoubtedly be obtainable from some manufacturer at a reasonable figure.

HOUSEHOLD WATER HEATERS

<u>State</u>	<u>Indiv. Monthly Averages</u>	<u>Average</u>	<u>Number in Family</u>	<u>Kw. hrs. per 100 gal.</u>	<u>Gallons per Month per Person</u>
Illinois	39-405	169	8	38	120
Kansas	80-100				
New Hampshire	120-241	182	5.6		
South Dakota	300-500	400			
Wisconsin		367	6	42	147
Average		239	6.5	40	135

There is still a great deal of difference of opinion in the Middle West and East as to the feasibility of the domestic water heater with energy at 3 cents per Kw. hr. Where an electric range is installed for cooking the electric water heater assumes considerable importance as a convenient method of heating water when other means are not available.

The energy consumption figures now available for the Middle West and East probably are not altogether representative of what may be expected when more is known about proper methods of handling the water heater. The average for the heaters on which data are available is around 35 Kw. hrs. per person per month in a family of six, this energy heating an average of a little less than 100 gallons of water. The consumption probably will be greater than for an electric range where the tank is well insulated to reduce the heat losses and is manually controlled. According to some figures from California, the consumption for their automatic domestic water heaters is about three times as high as the electric range.

A new combination solar and electric water heater which has been de-

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veloped in Alabama should furnish hot water at a very low cost in warm climates. In this case electricity is used as an auxiliary source of heat energy. There are reports that a combination solar and electric water heater will soon be on the market.

DISHWASHING

There is a wide difference of opinion as to the practicality of dishwashers. Some models are considered feasible for large families - seven or eight people. In only one case on test has a machine given satisfaction in a smaller family (5 members). This machine is on Test Farm No. 3 in New Hampshire and is no longer manufactured. It used 2 Kw. hrs. per month.

A dishwasher with two dish racks on Test Farm No. 6 in New Hampshire is no longer used as the farmer's wife felt that she could do the dishwashing by hand just as easily. There are five in the family. The dishwashers used in Wisconsin were similarly not practical for small families and in addition they were found very difficult to keep sanitary.

Some of the outstanding criticisms of dishwashers are:

1. Their inability to handle pots and pans.
2. Difficulty of keeping sanitary.
3. Small size of dish racks, in many making it impossible to let the dishes dry in the washer.
4. Large water requirements.

RADIO BATTERY CHARGES

A storage battery and a battery charger make it possible to operate the radio set under optimum voltage conditions at all times---quite important in getting "distance". Furthermore, with a trickle charger the storage battery may be practically forgotten.

The energy consumption will of course be extremely variable depending upon the type of set and number of hours it is used. However, in a more or less typical case, a battery charger used 10 Kw. hrs. per month during the winter and 4 Kw. hrs. per month during the summer, or an average of 7 Kw. hrs. per month for

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the year. A trickle charger probably will use 50 per cent more energy than an ordinary charger.

FLOOR SANDING, SCRUBBING, AND WAXING

Floor sanding, scrubbing, and waxing are back-breaking jobs which electric motors can do easily and effectively. The energy consumption is negligible, in a particular case 1 Kw. hr. scrubbing about 400 sq. ft. of floor space when the floor was scrubbed three or four times. The chief deterrent to the more general use of machines of this type is, of course, their high first cost.

MODERN FARM BELL

An electric signal horn is more effective and generally more satisfactory for calling the men folks to meals than the old farm bell of iron and brass.

HOUSEHOLD APPLICATIONS (Miscellaneous)

There are a great many devices such as curling irons, hair wavers, hair driers, immersion heaters, vibrators, phonograph and piano motors, household motors, kitchen aids, etc. which are giving splendid satisfaction on the farm. No consumption data are available but obviously it is negligible.

Air heaters are generally used for supplementary heating in the bathroom, children's playroom, etc. or for tempering the air in an unheated bedroom. They of course do away with the fumes of an oil stove and are cheaper to operate than the furnace for special occasions of short duration. The convenience of using these appliances is greatly appreciated.

According to some figures from Wisconsin, an air heater will consume an average of 3 to 3.5 Kw. hrs. per month when used to heat the children's playroom, temper a bedroom, or do some similar duty. In one special case an air heater was used to heat a living room in an emergency, consuming about 17 Kw. hrs. per day as an average.

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FARM LIGHTING

Monthly Farm Energy Consumption in Kw. hrs. for all Farm Lighting and Small Domestic Appliances

State	Average	
	Year	Winter Summer
Alabama	18	25 13
Iowa	25	
Kansas	21	
N. Hamp.	35.4	
Wisconsin	20	
Average	23.7	

The individual variations are considerable. For instance, the December consumptions in Iowa varying from 10 to 61 Kw. hrs. and the monthly individual maximums and minimums for Wisconsin running from 8 to 210 Kw. hrs.

Monthly Energy Consumption in Kw. hrs. for Barn Lighting

State	Average	Individual Maximum	Individual Minimum	Individual Averages
Iowa	9.0	14	5	- -
N. Hamp.	7.9	42	0	5.5 - 13.9
Average	8.5			

Monthly Energy Consumption in Kw. hrs. for House Lighting, including Small Household Appliances

State	Average	Individual Maximum	Individual Minimum	Individual Averages
Iowa	16	25	11	- -
N. Hamp.	34.6	59	6	15.2-63.3
Average	25.3			

The consumption figures for New Hampshire in the above tables do not cover a whole year, due to the unseasonable winter weather, but are probably quite representative for the year.

The energy consumption for lighting varies so much with such factors as locality and individual farm that it is difficult to draw general conclusions. However, it seems that 25 Kw. hrs. may be taken as a general average, a little less than 10 for the barn and the rest for the house. Almost two-thirds of the lighting energy used outside the house commonly goes for yard lighting. About one-half of the farmers in Alabama and similar districts are cotton farmers and do not even have their barns wired.

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Monthly Farm Energy Consumption in Kw. hrs. for all Farm Lighting and Small Domestic Appliances

State	Average	Year	Winter	Summer
Alabama	18	25	25	25
Iowa	21	21	21	21
Kansas	20	20	20	20
N. Hamp.	20	20	20	20
Wisconsin	20	20	20	20
Average	20.7	20.7	20.7	20.7

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State	Average	Maximum	Minimum	Individual	Individual	Individual
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N. Hamp.	7.8	42	0	5.5 - 12.2		
Average	8.5					

Monthly Energy Consumption in Kw. hrs. for House Lighting, including Small

State	Average	Maximum	Minimum	Individual	Individual	Individual
Iowa	16	25	11	Average	Individual	Individual
N. Hamp.	34.6	52	0	15.2-62.3		
Average	25.2					

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It is worthy of note that there is a distinct tendency for the energy consumption to increase as the convenience and value of better lighting becomes more generally appreciated.

Value of Barn Lighting

It has been found in Wisconsin that the farm chores can be done with electric lights in about two-thirds the time that is required with a lantern. One lamb feeder in Kansas was able to increase the capacity of his feeding barns by 20% by installing electric lights. The cost of operation was quite small.

Wiring Costs

A good job of wiring, including the fixtures, generally costs from \$300 to \$400, the fixtures ranging in price from \$25 to \$200, or say an average overall cost of \$7.50 per outlet. Each loop of wire is counted as an outlet. Generally there are 35 or 40 outlets per farm, with 10 or 12 of them outside the house, but on the Ohio Project there is a total of 65 outlets, 60% of them in the house.

It is interesting to note that the wiring costs at Renner were around \$166.00 per farm, and that in Idaho, where a special effort was made to keep costs down by eliminating expense in every way possible without sacrificing utility or general appearance, the cost per outlet was \$3.50 in the house and \$4.50 outside, including the yard lights. With some recent improvements, such as inside frosted lights, many practical opportunities for economy present themselves. More rugged material for the barn is being recognized as a necessity.

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WATER SUPPLY

(A) Domestic Pumping Data

State	Kw. hrs. per mo. Average consumption range	Kw. hrs. per mo. Average	Kw. hrs. per 1000 gals.	Type of System	Average Number in family	Average gal. per person per day
Ill.	1.3 - 4.4	2.4	1.85	Shallow well, mostly cisterns		31.6
Ind.	1.78- 2	1.89	1.75	Shallow well	5.5	8.3
Kans.	8.8 - 11	9.9	1.56	Deep well, 1 turbine, 2 reciprocating	4.5-(est.)	35.0
Minn.	1 - 7	2.6		Cistern Shallow well	5 - 3*	13.7-50*
N. Hamp.		3.7		Shallow well	5	
S. Dak.		2.7		Soft	7.5	
		6.4		Hard		
Wis.		4.5	.95	Shallow well	6	26.7

* Not the same families for which the energy consumption figures were obtained.

* Estimate

* 11 farms, not the same for which the other figures were obtained.

* One system only.

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N. Hamp.		3.7	Shallow well	6	
S. Dak.		2.7	Soft	7.5	
		6.4	Hard		
Wis.		4.5	Shallow well	6	26.7

* Not the same families for which the energy consumption figures were

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(B) Farm Pumping Data

State	Kw. hrs. per mo. Average consumption range	Kw. hrs. per mo. Average	Kw. hrs. per 1000 gals.	Type of System	Av. no. of ani- mals	Av. no. in fam.	Gals. per day per person and animal
Ala.	15.7 - 21	16	2.25	Deep well 1 pneumatic	25	3.5	9.42
Idaho		61.80		Shallow well	107	15	12.3 *
Ind.		37.5	.96	Shallow well	78*	9	15
Kans.		76.4	1.13	Shallow well	43	7	45#
Minn.	- - -	- -	1.	Shallow well	16*	3	13.8
Minn.	7.4 - 52.5	23	- -	- -	-	-	- - -
N. H.	15.5 - 39	27.7		2 Shallow 3 Deep	40*	5	
Ore.		15.6	2.9	shallow well	5*	4	20
Va.	7.8 - 23	17.4	1.55	2 Shallow 1 Deep	34*	3.7	13
Wis.	11.7-22.6	17.1		Deep well	28*	6.5	18 (3.5 & 17.7)

* Estimate or approximation

Retail Dairy

(C) Livestock Pumping Data

State	Kw. hrs. per mo. Average consumption range	Kw. hrs. per mo. Average	Kw. hrs. per 1000 gals.	Type of System	Number of animals	Kind of animals	Gals. per day per animal Average
Kans.		30	.37	Centrifugal	5,000	Sheep	.5 (1. in small flocks)
Minn.					75*	Cattle & hogs	2.9
S. Dak.	(1 - 60#	15 20.4			40* --	Cattle, horses & hogs --	-- --
Va.	17.8 - 33	25.4	1.22	Shallow well	64	Cows & Mules	7.6

* Estimate

11 farms, not the same for which the other figures were obtained.

Ø One system only.

(B) Farm Pumping Data

State	Kw. hrs. per mo. Average consumption range	Kw. hrs. per mo. Average consumption per mo. Average	Kw. hrs. per 1000 gals.	Type of System	Av. no. of ani- mals	Av. no. in farm	Gals. per day per person and animal
Pa.	15.7 - 21	16	2.25	Deep well 1 pneumatic	25	3.5	2.42
Del.		61.80		Shallow well	107	15	12.3 *
Ind.		27.6	.36	Shallow well	78*	9	15
Ans.		76.4	1.12	Shallow well	43	7	45#
Ill.	- - -	-	1.	Shallow well	18*	3	12.8
Ill.	7.4 - 22.5	23	-	-	-	-	-
I. H.	15.5 - 39	27.7		2 Shallow 3 Deep	40*	5	
Tex.		15.6	2.9	shallow well	5*	4	20
Ar.	7.8 - 23	17.4	1.55	2 Shallow 1 Deep	34*	2.7	13
Pa.	11.7-22.6	17.1		Deep well	28*	6.5	16 (2.5 & 17.7)

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Retail Dairy

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State	Kw. hrs. per mo. Average consumption range	Kw. hrs. per mo. Average consumption per mo. Average	Kw. hrs. per 1000 gals.	Type of System	Number of animals	Kind of animals	Gals. per day per animal Average
Ans.		80	.27	Centrifugal gal	5,000	Sheep	5 (1. in small flocks)
Ill.					75*	Cattle & hogs	2.9
Pa.	1 - 60#	15 20.4			40*	Cattle, horses & hogs	-
Ar.	17.8 - 33	26.4	1.22	Shallow well	64	Cows & Mules	7.6

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The water system and its equivalent motor, pump, and jack are together among the most popular of the higher priced farm conveniences, being very close competitors of the washing machine for first place.

Except for the high first cost, water supply systems with the conveniences such as a bathroom, etc., which are inseparable from them, would be as common as electric flat irons.

Energy Consumption

A. Monthly Consumption

1. The energy consumption of the water system is extremely variable, the averages ranging all the way from 1 to 60 or more Kw. hrs. per month on the average farm.

Where the systems supply the water for both domestic and livestock use the consumptions will average around 20 to 25 Kw. hrs. per month, individual monthly averages of course varying widely. In the South the averages will probably be around 16 to 18 Kw. hrs., due to the smaller amount of livestock and the mild weather which enables the stock to be in the pasture a large portion of the year, where they of course obtain a considerable part of their drinking water just as they do during a shorter season in the North.

2. The water system which furnishes all the water for domestic use will consume less than 10 Kw. hrs. as a general rule, in fact generally a great deal less until the family gets used to the convenience of running water and makes full use of it. When the system is first installed the consumption is frequently quite low, often about one-half of what it is a couple of years later.

Sanitary plumbing has a lot to do with the consumption. With a shallow well and full use the consumption will be around 4.5 to 5 Kw. hrs. for the average farm family of 5 or 6, and about twice that high with a deep well pump.

The average consumption with soft water systems is around 2.5 Kw. hrs. per month, the range as usual being very great. Of course, whatever soft water

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used cuts down in the same proportion on the rest of the domestic supply.

3. The energy consumption demands for the livestock alone will usually run around 12 to 15 Kw. hrs. per month, although on dairies and large stock farms it may climb to 25 or more Kw. hrs.

In many places the water system only supplements the windmill in calm weather and the consumption is proportionately lower. Due to the low operating cost and greater dependability of the electric water system it is not likely that many windmills will be replaced with newer models as they become incapacitated.

B. Energy Requirements per gal., etc.

1. The energy consumption per 1000 gal. pumped will usually range from 1 to 3.5 Kw. hrs., averaging not far from 1.6 Kw. hrs.

2. The energy consumption per 1000 gal. per 100 ft. of lift will be more variable, from a little over 1 Kw. hr. to 6 or 7 kw. hrs., averaging probably 2.5 Kw. hrs.

The H. P. of motors on water pumping systems and jacks usually ranges from $1/6$ to 2.

Pump Efficiencies

The overall efficiencies of most pumping units will range from 5 to 25%, averaging around 15%. The single acting pump makes the poorest showing and the double acting leads although the quick return pump jacks now on the market are sometimes even better.

Centrifugal and turbine pumps, (small), will usually have efficiencies of around 10 and 20% respectively.

The energy consumption of most water systems could be cut in two by the installation of a more efficient pump or jack.

Water Consumption

1. The water consumption for domestic use will range from 4 to 60 or more gals. per perso per day, although where ordinary full use of running water

used out down in the same proportion on the rest of the domestic supply.

3. The energy consumption demands for the livestock alone will usually run around 12 to 15 Kw. hrs. per month, although on dairies and large stock farms it may climb to 25 or more Kw. hrs.

In many places the water system only supplements the windmill in calm weather and the consumption is proportionately lower. Due to the low operating cost and greater dependability of the electric water system it is not likely that any windmills will be replaced with newer models as they become antiquated.

B. Energy Requirements per Gal., etc.

1. The energy consumption per 1000 Gal. pumped will usually range from

to 3.5 Kw. hrs., averaging not far from 1.8 Kw. hrs.

2. The energy consumption per 1000 Gal. per 100 ft. of lift will be

more variable, from a little over 1 Kw. hr. to 6 or 7 Kw. hrs., averaging probab-

y 2.5 Kw. hrs.

The H. P. of motors on water pumping systems and jacks usually ranges

from 1/8 to 2.

Pump Efficiencies

The overall efficiencies of most pumping units will range from 5 to 25%

averaging around 15%. The single acting pump makes the poorest showing and the

double acting leads although the disk return pump jacks now on the market are

sometimes even better.

Centrifugal and turbine pumps, (small), will usually have efficiencies

around 10 and 20% respectively.

The energy consumption of most water systems could be cut in two by the

installation of a more efficient pump or jack.

Water Consumption

1. The water consumption for domestic use will range from 4 to 60 or

more Gals. per person per day, although where ordinary full use of running water

is made it will be close to 35 gals. with a bath, or 20 gals. without, bathroom conveniences increasing the consumption about 60%. A small portion of the average consumption goes to water the lawn in dry weather. However, in some cases 1000 to 1200 gals. of water are used daily to water the garden and lawn, in which case the consumption is naturally higher.

The summer consumption is generally higher than the winter consumption under normal conditions.

2. Very little information is available on the water consumption of animals, but it is estimated that horses, mules, cattle and cows, or their equivalent in hogs (4 to 6), will each drink from 8 to 18 gals. of water per day, or probably an average of 12 gals. where they are shut up from other sources of water. Some consumption figures from Virginia give 7.5 gals. per head per day, but the animals were on pasture a great deal, due to the mild climate, and so had access to water in the field. In Minnesota the cattle drank twice as much water at the barn in the winter as they did in the summer after they were on pasture. This is probably typical.

Sheep will require about .5 gal. of water per day in large flocks, or about twice that in small flocks, probably due to greater losses and waste.

It is estimated that 100 chickens, (young and old), will, on the average, drink 2.5 gals. of water daily.

Conclusions

1. A cheap and reliable inverse time relay should be sold as an integral part of each pump installation to protect it against low voltage, since fuses large enough to permit starting will let the motor burn out on low voltage, as many farmers have found out.

2. A turbine pump has several advantages as compared to the ordinary reciprocating pump and is no more expensive, generally being less so, for comparable capacities. It is a high speed pump and can therefore be direct-connected. There is no danger of water hammer and the starting torque is low.

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Conclusions

1. A cheap and reliable inverse time relay should be sold as an integral part of each pump installation to protect it against low voltage, since fuses large enough to permit starting will let the motor burn out on low voltage, as many farmers have found out.

2. A turbine pump has several advantages as compared to the ordinary reciprocating pump and is no more expensive, generally being less so, for comparable capacities. It is a high speed pump and can therefore be direct-connected. There is no danger of water hammer and the starting torque is low.

3. A Brown and Sharpe #1 gear pump will have a capacity of from 90 to 270 gals. per hour, depending on the speed, (300 to 900 R. P. M.). The higher capacity would probably require a $\frac{1}{2}$ H. P. motor. The outfit complete with a $\frac{1}{4}$ H. P. motor would not cost over \$35 retail (Pump, \$11). These pumps will develop considerable pressure and are self priming when new. If they get so they won't prime in a year or so, the farmer can buy a new pump and still be ahead about \$100. They of course are especially well adapted to open tank pumping for livestock.

4. An inexpensive valve which would permit the open stock tank to be filled automatically by the pressure water system of the house when the windmill allowed the water in the tank to get too low, would be very popular in the middle west.

FIRE PROTECTION

It takes a considerable volume of water to give worthwhile fire protection. This quantity of water, under practical conditions, must be furnished in part by storage and in part by pumping. Two H. P. is probably the minimum size of motor that would be practical for such a purpose. This is of course larger than the motor on most water systems.

The importance to the farmer of adequate fire protection led the Agricultural Experiment Station of the Alabama Polytechnic Institute to make a study of the subject, the results of the study being published in Circular #49 in 1926. In these tests a 1200 gal. Gould pump, operated by a 2 H. P. motor, and a 500 gallon storage tank, together with 150 ft. of 2 inch hose and a $\frac{1}{2}$ -inch nozzle, were used. The tank pressure at the start was 45 lbs., the pump cutting in at 25 lbs. pressure 10 minutes later. Twenty minutes after the test was started the pressure had dropped to 17 lbs. and remained there during the rest of the test. Four hundred (400) gals. of water were delivered in 20 minutes by the $\frac{1}{2}$ -inch nozzle. The mains were 2 inches in diameter.

3. A Brown and Sharpe $\frac{1}{2}$ inch gear pump will have a capacity of from 90 to 270 gals. per hour, depending on the speed, (300 to 500 R. P. M.). The higher capacity would probably require a $\frac{1}{2}$ H. P. motor. The outfit complete with a $\frac{1}{2}$ H. P. motor would not cost over \$35 retail (Pump, \$11). These pumps will develop considerable pressure and are self priming when new. If they get so they won't prime in a year or so, the farmer can buy a new pump and still be ahead about \$100. They of course are especially well adapted to open tank pumping for livestock.

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The importance to the farmer of adequate fire protection led the Agricultural Experiment Station of the Alabama Polytechnic Institute to make a study of the subject, the results of the study being published in Circular #48 in 1926. In these tests a 1200 gal. Gould pump, operated by a 2 H. P. motor, and a 500 gallon storage tank, together with 150 ft. of 2 inch hose and a $\frac{1}{2}$ inch nozzle, were used. The tank pressure at the start was 45 lbs., the pump cutting in at 35 lbs. pressure 10 minutes later. Twenty minutes after the test was started the pressure had dropped to 17 lbs. and remained there during the rest of the test. Four hundred (400) gals. of water were delivered in 20 minutes by the $\frac{1}{2}$ inch nozzle. The main were 2 inches in diameter.

As a result of the tests it was felt that the nozzle should be adjustable so that the water pressure could be kept at the proper figure, it of course being very desirable to be able to throw a lot of water in a short while at the start, when the fire is more easily brought under control.

The protection afforded by the above installation was about the same as that furnished by chemicals.

MILKING MACHINES

Portable Machines

<u>State</u>	<u>Kw. hrs. per mo. per 10 Cows</u>
Indiana	13.8
Wisconsin	14.8
Average	12.8

Pipe Line Machines

<u>State</u>	<u>Kw. hrs. per mo. per 10 Cows</u>
Alabama	25.0
California	24.0
Illinois	27.4
Indiana	27.6
Iowa	25.2
Kansas	44.7
Minnesota	27.3
Nebraska	37.0
New Hampshire	30.5
South Dakota	25.0
Wisconsin	48.5
Average	31.1

There was a great range in the data from which the pipe line machine table was prepared. The minimum was 12.1, and the maximum, 91 Kilowatt hours per month per 10 cows.

Time

In Ohio, time studies were conducted on hand milking on 13 farms for 50 days. The average number of cows was 6.84 per farm. The time required per cow per day ranged from 10.8 man-minutes to 25.2 man-minutes. The general average was

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MILKING MACHINES

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Wisconsin	14.8
Average	<u>12.8</u>

Pipe Line Machines

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Alabama	25.0
California	24.0
Illinois	27.4
Indiana	27.6
Iowa	28.2
Kansas	44.7
Minnesota	27.3
Nebraska	27.0
New Hampshire	30.5
South Dakota	28.0
Wisconsin	48.5
Average	<u>31.1</u>

There was a great range in the data from which the pipe line machine table was prepared. The minimum was 12.1, and the maximum, 51 Kilowatt hours per month per 10 cows.

time

In Ohio, time studies were conducted on hand milking on 12 farms for 50 days. The average number of cows was 8.84 per farm. The time required per cow per day ranged from 10.8 man-minutes to 25.2 man-minutes. The general average was

17.75 man-minutes per cow per day. In addition to this, it required an average of 11.5 man-minutes per farm per day to care for the dairy utensils. There were an average of 8.1 pieces per farm.

In California, time studies were conducted on machine milking on seven dairies having from 20 to 420 cows. The average milking time was 11.8 man-minutes per cow per day, which included the care of the equipment in most cases. The minimum of 8.4 man-minutes per cow per day was on a farm with 86 cows, using a machine with two double units. The maximum, 15.3 man-minutes per cow per day, was on a farm with 20 cows, using a double unit machine.

Indiana studies show that the time for hand milking without the care of equipment ranged from 13.5 to 17.6 man-minutes per cow per day. With machine milking, the time, including care of the milking machine, ranged from 8 to 9 man-minutes per cow per day. Indiana further reports that the use of a portable milking machine reduced the milking time by 41% with one herd, while a pipe line machine reduced the time by 45% in another herd.

Reports from Illinois and Kansas indicate that it requires about 20 minutes per day to care for a milking machine with two double units although this varies greatly with different machines.

The above figures represent average conditions. There are reasons to believe that in a properly organized dairy a much greater time saving can be effected through the use of the milking machine.

The 1/6 H. P. motor is coming to be recognized as standard for the portable double unit milking machine. There is a great variation in the size of motor required to operate pipe line milking machines, apparently depending upon type of machine used as well as efficiency of installation. This variation ranges from 1/8 H. P. to 3/4 H. P. per cow milked at one time. Thus, if 4 cows are milked at one time the motor requirements would range from $\frac{1}{2}$ H. P. to 3 H. P.

There are two serious problems to be met in milking machine operation,

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There are two serious problems to be met in milking machine operation.

viz: low voltage and sanitary conditions. A number of the manufacturers of milking machines complain about electrical operation because of most unsatisfactory experiences with voltage drop. In many cases the milking machine has been discarded or not purchased because of high bacterial count which is supposed to attend its use. Fortunately both of these problems can be successfully solved.

D A I R Y R E F R I G E R A T I O N

Milk Cooling and Storing

<u>State</u>	<u>Av. Kw. hrs. per month</u>	<u>Kw. hrs. per mo. per 100 qts. of milk</u>	<u>Storage Capacity</u>	<u>Insulation</u>
Alabama	50	62.5	4' x 4' x 8'	3 layers of Celotex and 2" air space.
Alabama		75.0	3' x 6' x 30"	4" ground cork
Alabama	500	60.0#	6' x 8' x 7'	4" Cork Board
New York	300*	110*	160 qt. max.	6" Concrete and 2 or 3" corkboard

This 2-ton ammonia plant also furnished ice for the cases of bottled milk when they were loaded for delivery. The storage room was kept at 40°F.

* Estimate.

Milk Storage

(Table 19 from New Hampshire Bulletin No. 228)

<u>Farm No.</u>	<u>Quarts stored</u>	<u>Kw. hrs. per 30 day period *</u>			<u>Extent of Record</u>
		<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>	
1	300	0	226	96.5	April to December 1926
2	300	0	164	112	Aug. 1925 to December 1926
4	300	0	175	148	April to December 1926
Average	300	0	188	119	

* Approximately
8 months

The storage boxes on farms No. 1 and 4 contain about 190 cu. ft. of space and that on No. 2, about 150 cu. ft. The effect of location on energy consumption is well illustrated by the boxes on farms No. 1 and 4, No. 1 being located in a cool basement but having only 3" of corkboard insulation on the sides and roof and nothing but concrete on the floor, whereas No. 4 is completely insulated with 4" of corkboard and is well protected from extreme temperature changes but is located on the ground floor. A minor portion of the 50% greater energy consumption of No. 4 is probably due to its use for food storage.

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DAIRY REFRIGERATION

Milk Cooling and Storing

State	Average per month	Kw. hrs. per 100 lbs. of milk	Storage Capacity	Insulation
Alabama	50	62.5	4' x 4' x 8'	3 layers of Celotex and 2" air space.
Alabama		75.0	2' x 8' x 30"	4" ground cork
Alabama	500	60.0	6' x 8' x 7'	4" Cork Board
New York	500*	110*	150 qt. max.	6" Concrete and 2 or 3" corkboard

This 2-ton ammonia plant also furnished ice for the cases of bottled milk when they were loaded for delivery. The storage room was kept at 40°F.

Estimate.

Milk Storage

(Table 12 from New Hampshire Bulletin No. 228)

Period	Quarts stored	Kw. hrs. per 30 day period *	Minimum	Maximum	Average	Extent of Record
April to December 1926	300	0	226	96.5		April to December 1926
Aug. 1925 to December 1926	300	0	164	112		Aug. 1925 to December 1926
April to December 1926	300 300	0 0	175 188	148 115		April to December 1926

Approximately
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The storage boxes on farms No. 1 and 4 contain about 150 cu. ft. of space and are on No. 2, about 150 cu. ft. The effect of location on energy consumption is all illustrated by the boxes on farms No. 1 and 4, No. 1 being located in a cool basement but having only 3" of corkboard insulation on the sides and roof and nothing but concrete on the floor, whereas No. 4 is completely insulated with 4" of corkboard and is well protected from extreme temperature changes but is located on the ground floor. A minor portion of the 50% greater energy consumption of No. 4 is probably due to its use for food storage.

Energy Consumption

1. (a) With well insulated boxes it seems entirely practical to keep the average energy consumption per day for each 10 gallon can cooled and stored at 1 Kw. hr., or 75 Kw. hrs. per month per 100 quarts.

(b) Where milk is merely stored, the energy consumption will be around 40 or 50 Kw. hrs. per month per 100 quarts stored, the radiation losses of course constituting a materially higher percentage of the total consumption than where the milk is also cooled. In the North, this figure could be lowered by placing the box in the basement so as to take advantage of the lower average temperature of the soil as compared to the air.

Note: The figures in (a) and (b) are based on the 6 months of late Spring, Summer and early Fall, as artificial refrigeration is seldom used during the rest of the year. Of course, in the South, the plant will be used practically all of the time even though the consumption will be somewhat lower for the winter months. It is quite likely that dairymen will eventually use their plants the year around, even in the Middle West, the winter energy consumption of course still being low, due to outside temperatures.

2. According to some figures from a 2-ton ammonia plant in Alabama, 2.8 Kw. hrs. will replace 100 lbs. of ice. However, this figure is somewhat low as a better storage box was built when the ice plant was installed. Three (3) Kw. hrs. is probably about right.

Conclusions

The cost of a good ice house will generally be as high as that of a good refrigerating unit which will take its place. Furthermore, the energy will usually be no higher in total cost than the ice, even though the ice is free for the gathering, the farmer's time being considered. A dairyman is usually busy even during the winter. The farmer will need to store about 50 pounds of ice for each 10 gallon can of milk he expects to cool the following summer, or 50 pounds for each Kw. hr. the refrigerating unit will consume in a well constructed and well insulated box.

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an ordinary box. Not less than 4 inches of corkboard or its equivalent should be used, the floor being just as well insulated as the rest. Cork dust or ground cork is just as satisfactory, inch for inch, as corkboard. Three layers of Celotex and a 2 inch dead air space are more effective than 4 inches of corkboard. The box itself should be rather inexpensive.

For sanitary reasons all boxes should be coated inside with about $\frac{1}{2}$ inch of cement. This coating will also protect the insulation from moisture. Furthermore, the use of concrete makes practical the placing of at least a portion of the box below the ground, as is the general practice in New York, or its location in the basement, as is the case of one of the test boxes in New Hampshire.

MILK COOLING WATER PUMP

A small electric motor for pumping water through the coils of a milk cooler will save a great deal of time in stirring the water and ice in the "aerator", for otherwise the temperature of the milk would not be lowered sufficiently. The milk temperature should be reduced to at least 50°F. Where there is an abundance of cold water no ice will be needed. Many dairymen pump water from a tank containing ice, while others cool with brine from an electric refrigerating unit. In any case, a $\frac{1}{4}$ H. P. motor will drive the small centrifugal pump commonly used.

Energy Consumption

One dairy farmer in New Hampshire pumps the water from a shallow well through the milk cooler and back into the well with a $\frac{1}{4}$ H. P. motor and a small pump. The maximum energy consumption was around 10 Kw. hrs. per month, in July and August, and the minimum, around 4 Kw. hrs., in February. The average per month for the year was around 7.8 Kw. hrs., or 2.6 Kw. hrs. per month per 100 quarts, 300 quarts having been cooled daily.

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DAIRY EQUIPMENT STERILIZERS

In two states, Alabama and California, development work has been undertaken on dairy equipment sterilizers using electricity as a source of heat energy.

In Alabama, considerable success has been experienced in developing a low pressure steam sterilizer. This is still in the experimental stage with every promise of a successful conclusion. The chief feature of this development is the small amount of water used. In California an extensive series of tests and development studies have been conducted on electrically operated dairy equipment sterilizers. There is a legal requirement in California that dairy utensils be sterilized at 170°F. for at least fifteen minutes. The designs in this state have been developed to meet this requirement.

California Tests on Dairy Equipment Sterilizers *

No.	Water used Lbs.	Observed Demand Watts	Type of Insulation	Min. above 170°F.	Average Kw. hrs.			Minutes to 210°F.
					To 210°F.	210°F. 5 min.	210°F. 10 min.	
1	50	5,736	Insulated lid, plain body	32.5	3.48	3.97	4.44	36.5
2	17	2,883	Plain lid, air jacket body	42.5	2.60	2.84	3.08	24.1
3	17	2,941	Asbestos filled lid, air jack. body	47.0	2.29	2.53	2.78	46.7
4	17	5,716	None	22.0	2.35	2.83	3.30	24.6
5	17	5,614	Plain lid, air jacket body	28.0	2.23	2.70	3.17	23.8
6	17	5,625	Asbestos filled lid, air jack. body	33.5	2.07	2.53	3.00	22.0
7	17	5,557	Air jacket lid and body	41.0	2.02	2.48	2.94	21.8
8	10	5,607	None	21.0	2.10	2.57	3.04	22.5

* The sterilizers were the 4-can size.

In a California field test with a 4-can insulated dairy equipment sterilizer, using a 3-Kw. heating unit, it was found that 3.78 Kilowatt hours of electricity were required per sterilization. There were 22 cows in the herd. The

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California Tests on Dairy Equipment Sterilizers *

Water used Lbs.	Observed Demand Water	Type of Insulation	Min. above 170°F.	Average Kw. hrs. To 210°F. 5 min.	To 210°F. 10 min.	Minutes to 210°F.
50	5.738	Insulated lid, plain body	32.5	3.48	3.37	4.44
17	5.883	Plain lid, air jacket body	42.5	3.60	3.64	3.08
17	5.941	Asbestos filled lid, air jacket body	47.0	2.39	2.53	2.78
17	5.716	None	32.0	2.35	2.63	3.30
17	5.614	Plain lid, air jacket body	38.0	2.33	2.70	3.17
17	5.825	Asbestos filled lid, air jacket body	33.5	2.07	2.53	3.00
17	5.557	Air jacket lid and body	41.0	2.03	2.48	2.94
10	5.607	None	21.0	2.10	2.57	3.04

* The sterilizers were the 4-can size.

In a California field test with a 4-can insulated dairy equipment sterilizer, using a 3-Kw. heating unit, it was found that 3.78 kilowatt hours of electricity were required per sterilization. There were 22 cans in the herd. The

utensils sterilized weighed 58.4 lbs. As a result of the California studies the following recommendations were made with reference to the 4-can sterilizer:

1. A sanitary insulation against heat loss is essential.
2. A properly insulated sterilizer will permit the turning off of the power as soon as a temperature of 210°F. is reached. Inefficient insulation may make it necessary to hold the temperature at 210°F. for several minutes before turning off the heat.
3. As little water as possible should be used.
4. Heating 15 gal. of water for washing purposes from 70°F. to 120°F. consumes somewhat less electricity than that required for sterilization.
5. Some system of automatic control should be incorporated that will interrupt the circuit at the proper time without personal attention. This may be a thermostat or a time switch.
6. The heating element should be as near 5 K. W. as the connected load will permit.
7. Circulation of water in the heating compartment will facilitate heating.
8. The water compartments should be so designed as to use the minimum of water without dead spaces.
9. The use of electricity for sterilization is possible and seems to be practical from the standpoints of service and economy under California conditions.

CREAM SEPARATORS

<u>State</u>	<u>Kw. hrs. per 1000 lbs. Milk</u>
Alabama	1.1
Illinois	.4- .61
Kansas	.25
Wisconsin	.3

Cream separators of ordinary farm sizes are equipped with motors ranging from $1/8$ H. P. to $1/4$ H. P. The $1/8$ H. P. size will handle up to 1000 lbs. of milk per hour and the $1/4$ H. P. size, up to 1400 lbs. per hour.

From the energy consumption data given above it is evident that the Alabama figure is considerably above the average for other states.

materials sterilized weighed 58.4 lbs. As a result of the California studies the

following recommendations were made with reference to the 4-can sterilizer:

1. A sanitary insulation against heat loss is essential.
2. A properly insulated sterilizer will permit the turning off of the power as soon as a temperature of 210°F . is reached. Inefficient insulation may make it necessary to hold the temperature at 210°F . for several minutes before turning off the heat.
3. As little water as possible should be used.
4. Heating 15 gal. of water for washing purposes from 70°F . to 120°F . consumes somewhat less electricity than that required for sterilization.
5. Some system of automatic control should be incorporated that will interrupt the circuit at the proper time without personal attention. This may be a thermostat or a time switch.
6. The heating element should be as near 5 K. W. as the connected load will permit.
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State	Kw. hrs. per 1000 lbs. Milk
Alabama	1.1
Illinois	4-.61
Kansas	.25
Wisconsin	.3

Cream separators of ordinary farm sizes are equipped with motors ranging from $1\frac{1}{8}$ H. P. to $1\frac{1}{4}$ H. P. The $1\frac{1}{8}$ H. P. size will handle up to 1000 lbs. of milk per hour and the $1\frac{1}{4}$ H. P. size, up to 1400 lbs. per hour.

From the energy consumption data given above it is evident that the Alabama figure is considerably above the average for other states.

CHURNING

A small electric motor will save a great many monotonous hours of churning, during the course of a year, on the farms where butter is being made. In a typical case in Indiana a 1/4 H. P. portable motor with a gear reduction and stop pulley was used to operate an ordinary 6-gallon barrel churn. It took about 1/6 Kw. hr. per churning or 17 Kw. hrs. per year, a churning apparently taking about 20 minutes on the average.

WATER HEATING FOR THE DAIRY

<u>State</u>	<u>Av. Kw. hrs.</u> <u>per Month</u> <u>per 10 Cows</u>	<u>Av. gals. of</u> <u>Water per Mo.</u> <u>per 10 Cows</u>	<u>Kw. hrs. per</u> <u>per</u> <u>100 gals. water</u>
California	75 *		
Washington	100	550	18.2
Wisconsin	52	120	47 **

* Estimated

** In Wisconsin the storage tank held but 10 gallons and the water was heated to a higher temperature than in Washington.

A supply of hot water is necessary if the utensils, bottles and other equipment in a dairy are to be properly cared for. An electric water heater will furnish this hot water with a minimum of worry and trouble.

Energy Consumption and Water Requirements

Obviously the water consumption will vary tremendously with the individuality of the farmer, type of motor, etc. However, on the average it will apparently take around 75 Kw. hrs. per month per 10 cows to heat the average amount of water required---around 400 gallons per month. The amount of water used will depend to a large extent upon the temperature to which it is heated, other things being equal.

Conclusions

For dairy water heating by electricity to be practical it would seem necessary that a minimum rate of 3 cents per Kw. hr. be available.

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California	75 *			
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Conclusions

For dairy water heating by electricity to be practical it would seem necessary that a minimum rate of 3 cents per Kw. hr. be available.

The storage tank should hold not less than 10 gallons of water and should be well insulated. It need not be connected to a pressure water system altho such a connection is desirable. In one case in Wisconsin the tank was filled with a bucket and funnel.

The heating element should always be controlled by an automatic thermostat as otherwise there is not only danger of burning out the elements but also a real fire hazard, as one Wisconsin farmer found. With such an automatic thermostat a small heating element may be practical.

BOTTLE WASHING

State	Motor Size	Kw. hrs. per 1000 bottles
Kansas	1/2 H. P.	.5
New Hampshire	1/6 H. P.	.25

The electric motor is a satisfactory motive power for the bottle washer. The outfit may be either direct-connected or belt-driven. Contrary to the opinions of some, the brush on bottle washers can be successfully operated at 1800 R. P. M. Where the ordinary belt drive is used some trouble has been experienced due to slippage. In Kansas this difficulty was overcome by making a belt from two screen door springs, which has operated successfully for two years. A 1/6 H. P. motor is large enough for this work. For satisfactory bottle washing a supply of hot water is necessary.

DRINKING CUPS FOR COWS

A limited test conducted in Minnesota indicates a marked increase in milk production when indoor drinking cups are used. The data are graphed on the accompanying chart. On this basis a 15% yearly increase in milk production is indicated. Studies on this same subject by the U. S. Department of Agriculture conducted in eastern Maryland showed a 5% increase in milk production. This

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BOTTLE WASHING

State	Motor Size	Kw. hrs. per 1000 bottles
Kansas	1 1/2 H. P.	5
New Hampshire	1 1/8 H. P.	25

The electric motor is a satisfactory motive power for the bottle washer. The outfit may be either direct-connected or belt-driven. Contrary to the opinions of some, the brush on bottle washers can be successfully operated at 800 R. P. M. Where the ordinary belt drive is used some trouble has been experienced due to slippage. In Kansas this difficulty was overcome by making a lift from two screen door springs, which has operated successfully for two years. 1/8 H. P. motor is large enough for this work. For satisfactory bottle washing supply of hot water is necessary.

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variation is probably due in a large measure to the differences in climatic conditions. It is still a question as to whether these increases were not due to the warm water. Many authorities on the subject consider warm water as the primary cause. If this is true, an indoor tank might be just as efficient.

ANIMAL GROOMER

The animal groomer offers the progressive dairyman an opportunity to produce better milk with less trouble. It will thoroughly remove the loose hair from the udder, flanks, etc. without permitting it to escape into the stable air. It is just one more of the many conveniences offered to the dairyman by electricity.

BULL TAMER

A ferocious bull has unusual respect for electricity. In Wisconsin equipment for this purpose was arranged by coupling a Ford coil with a bell-ringing type transformer. Connections were made between the coil and two sharp terminals separated three or four inches and mounted on a wooden pole. Care should be exercised as many animals are very susceptible to electric shock.

FLY CONTROL

An electric fan has proven very effective in New Hampshire in keeping flies away from open cans and bottles of milk and cream while the bottling is being done. A few flies are sure to be around, even in a well-screened milkhouse. The fan, of course, would be equally effective in the kitchen or dining room.

One farmer's wife used her vacuum cleaner to remove the flies from the ceiling of the outside porch early in the morning while they were still stiff from the morning air.

The electricution pads have not proven very successful due to the shorting of the wires by the dead flies.

From foul odors and dampness. In LIQUID MANURE PUMP this is unfavorable weather

There is probably no section in the United States, outside of the Tillamook dairy district in Oregon, where the farmers have liquid manure pits or cisterns. However, here they are an established institution and the liquid manure pump is almost a necessity. The electric motor, of course, offers the most reliable type of motive power for such pumps. One farmer who has purchased a "Luna" pump from Switzerland expects to operate it with the milking machine motor by merely changing the belt from the milker pump to the liquid manure pump. The energy consumption is of course negligible. It has several advantages as compared to the natural draft system:

1. Lower overall first cost BARN VENTILATION compared to \$900.00 in a typical case in Minnesota).

The operating cost of Kw. hrs. per year is Kw. hrs. per season per 100 head of stock. The interest and depreciation on the extra investment in a typical case in Minnesota).

State	Kw. hrs. per year	Kw. hrs. per season per 100 head of stock
Minnesota	300	1,000
Minnesota	36	144
New York *	810	1,250

* The tests in New York are not yet complete.

Energy Consumption

The energy consumption of exhaust fans used for ventilating barns will of course be quite variable, depending upon the type and construction of the barn, individuality of the farmer, and climatic conditions, as well as the size of the barn. However, in barns housing 30 or more cattle, or their equivalent in other stock, it should not take over 1,000 Kw. hrs. per season per hundred animals for ventilation during the total of three months that the fans will be operated under normal conditions. In smaller barns the consumption probably will be somewhat higher. The energy consumption for New York probably is higher than it would be if the fans exhausted directly into the outside air instead of thru flues.

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Ordinarily a barn is said to be well ventilated when it is kept free

from foul odors and dampness. In order to accomplish this in unfavorable weather it is sometimes necessary to remove the air at the rate of 72 cu. ft. per minute per animal, according to some work done in Minnesota. However, under normal conditions the removal of 40 to 45 cu. ft. will prove satisfactory. In this connection it is interesting to note that exhaust fans actually have an air capacity (at least for this type of work) of about 45 per cent of their rating. For example, a 60 watt 12 in. fan rated at 2500 cu. ft. of air per minute actually delivers but 1150 cu. ft. per minute.

The forced draft system of barn ventilation has several advantages as compared to the natural draft system:

1. Lower overall first cost. (\$350.00 as compared to \$900.00 in a typical case in Minnesota). The operating cost of the fans is generally lower than the interest and depreciation on the extra investment in a gravity system.

2. Exhaust fans work against the wind and therefore are independent of wind direction and velocity. Gravity ventilated barns are liable to be cold on blustery days and poorly ventilated on warm, damp days---the very times when proper ventilation is most desired.

3. Since the inside air is exhausted by the fans the outside air is drawn in thru the door cracks with the result that they do not freeze shut---a very common occurrence in the gravity ventilated barn.

Not less than three fans should be installed, two on the leeward side, as otherwise the ventilating system will not be flexible enough for the different kinds of weather. In this way only the optimum amount of air need be removed. It will result in better and more economical ventilation. In a very small barn this of course will make the first cost and installation of ventilating equipment rather high.

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ENSILAGE CUTTING

Energy Consumption Figures for Ensilage Cutters

<u>State</u>	<u>Kw. hrs. per ton</u>	<u>Height of Silo</u>	<u>Type of machine and size of throat</u>	<u>Material cut</u>	<u>H. P. used</u>	<u>Tons per hour</u>
Alabama	2.4	- -	14" Papec	Sorghum	15	-
Idaho	1.8	40'	11" McCormick Deering	Corn	10	4.3
Illinois	1.75	40'	16" " "	Corn	15	8
Kansas	2.28	35'*	- -	Corn	40	5.25
New York	.67	30'	13" Gehl	Corn	5	8
Oregon ^{###}	1.36-3.75	-	- -	Sunflowers, weeds, corn	15	-
Washington	1.	26'	10" Papec	Corn	5	6.1
Wisconsin	.7*	35'	13" Rowell	Corn	5	5 - 8

* Estimate

^{###} Excessive speeds

Summary of Tests Made at the New York State College of Agriculture at Ithaca, Autumn 1926 *

<u>Run No.</u>	<u>Unloading time, min.</u>	<u>Kw. hrs. per ton</u>	<u>H. P.</u>	<u>Tons per load</u>	<u>Tons per hr.</u>	<u>Tons cut</u>	<u>Remarks</u>
4	9.75	.598	7.63	1.506	9.50	22.61	Cut 1" - Bundles
5	9.53	.642	7.51	1.385	8.82	12.46	Bundles, knives used $\frac{1}{2}$ day
	10.06	.600	4.80	1.000	5.97	1.00	Loose, knives used $\frac{1}{2}$ day
	14.29	.678	5.94	1.548	6.58	6.20	Loose, Sunflowers, Knives used $\frac{1}{2}$ day
6	7.75	.615	7.62	1.200	9.25	19.21	Bundles, Sharp knives
7	8.88	.665	7.28	1.238	8.25	26.00	" " "
88	9.07	.610	7.56	1.398	9.28	26.58	"
	10.80	.850	6.70	1.058	5.88	1.06	Loose corn
9	9.99	.630	6.90	1.362	8.35	16.36	Loose corn, sharp knives
10	10.60	.670	7.63	1.491	8.55	17.90	Bundles, Knives used $\frac{1}{2}$ day
11	11.82	.738	7.65	1.523	7.95	4.57	
	8.00	.686	7.06	1.020	7.68		
Average	12.00	.665	7.02	1.310	8.00	154.97	

* Approximately 150 tons were ensiled

ENSLAVER CUTTING

Energy Consumption Figures for Enslaver Cutters

State	Kw. hrs. per ton	Height of silo	Type of machine and size of throat	Material cut	H. P. used	Tons per hour
Alabama	2.4	-	14" Paper	Sorghum	15	-
Idaho	1.8	40'	11" McCormick Deering	Corn	10	4.3
Illinois	1.75	40'	" "	Corn	15	8
Kansas	2.28	35'	-	Corn	40	5.25
New York	.67	30'	13" Gehl	Corn	5	8
Oregon	1.25-3.75	-	-	Sunflowers, weeds, corn	15	-
Washington	1.	25'	10" Paper	Corn	5	6.1
Wisconsin	.7*	35'	13" Rowell	Corn	5	5 - 8

* Estimate

** Excessive speeds

Summary of Tests Made at the New York State College of Agriculture at Ithaca, Autumn 1928 *

No.	Unloading time, min.	Kw. hrs. per ton	H. P. per load	Tons per hr.	Tons cut	Remarks
4	9.75	.598	7.63	1.506	9.50	Cut 1" - Bundles
5	9.53	.643	7.61	1.385	8.83	Bundles, knives used $\frac{1}{2}$ day
	10.08	.600	4.80	1.000	5.97	Loose, knives used $\frac{1}{2}$ day
	14.29	.676	5.84	1.648	6.58	Loose, Sunflowers, Knives used $\frac{1}{2}$ day
6	7.75	.615	7.63	1.300	9.35	Bundles, Sharp knives
7	8.68	.665	7.28	1.338	8.35	" "
8	9.07	.610	7.53	1.333	9.38	" "
	10.80	.650	6.70	1.058	5.68	Loose corn
9	9.99	.630	6.90	1.363	8.35	Loose corn, sharp knives
10	10.80	.670	7.63	1.431	8.55	Bundles, Knives used $\frac{1}{2}$ day
11	11.82	.738	7.65	1.523	7.95	4.57
	8.00	.686	7.08	1.080	7.63	
Average	12.00	.665	7.05	1.310	8.00	154.97

* Approximately 150 tons were crated

Energy Consumption

Due largely to the different methods of operating, the energy consumption per ton of an ensilage cutter is extremely variable, ranging from .7 Kw. hrs., or less, to 3.5 Kw. hrs. Under proper conditions it should not take over .7 Kw. hrs. per ton to fill a 30 to 35 foot silo.

The H. P. used ranges all the way from 5 to 40.

Important Factors in Determining Energy Requirements

(a) The most important single factor in determining the energy requirements of ensilage cutters is the speed of operation. If the speed is excessive considerable energy is wasted in air friction. The speed should be such that the corn or other material will just elevate safely when the cutter is under full load. At higher speeds the cutter will operate less efficiently and tax the motor more severely.

(b) It is very essential for economical operation that the clearance between the housing and fan blades be not excessive, ($1/8$ to $1/4$ " usually) according to Professor F. W. Duffee.

(c) Dull knives will increase the power requirements about 50% on the average. Sharp knives should be put on the machine each day, - under unfavorable conditions, probably twice daily.

(d) The kind of material being ensiled is quite important in determining the energy consumption per ton. Some things, such as weeds, etc., require more than twice as much energy as corn. Sunflowers do not require much more than corn. Loose corn will require 10 to 15% more energy per ton than bundle corn. This is largely due, no doubt, to the smaller amount of corn the cutter throat will handle as the energy consumption of an idling cutter is about 50% as high as when it is under full load. This latter statement of course assumes reasonably sharp knives.

Due largely to the different methods of operating, the energy consumption per ton of an ensilage cutter is extremely variable, ranging from 7 Kw. hrs. or less, to 3.5 Kw. hrs. Under proper conditions it should not take over 7 Kw.

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FEED GRINDING

Conclusions

Energy Consumption Figures in Kw. Hrs. per ton

From the work at Wisconsin and New York, it appears entirely practical to use a 5 H. P. motor to operate an ensilage cutter with a 13" throat, i. e., as long as the cutter is properly designed and the knives kept sharp. In New York, the cutter was operated with two knives, the corn being cut into 1 inch lengths. 150 tons were ensiled satisfactorily with a 5 H. P. motor and a 13 inch Gehl cutter. The 30 foot silo was filled at the rate of 8 tons per hour. This work required an average of 7.02 H. P. but, due to the intermittent nature of the work, the motor was not over-taxed in any way. As a matter of fact it is not likely that the motor could be injured under the above conditions.

Until manufacturers work out speed tables for their machines it will be helpful to know at approximately what speed the cutter should operate to fill a given silo efficiently. The determining factor, of course, is the rate of travel of the fan blade tips. The Gehl cutter used at Cornell had a 37 inch fan and was operated at 480 R. P. M. when filling a 30 foot silo. From this data, the approximate speed can be determined for any other condition. Some ensilage cutters may run just heavy enough to make a 5 H. P. motor impractical. Furthermore, silos higher than 30 to 35 feet would seem to be out of the question with less than a $7\frac{1}{2}$ H. P. motor.

Energy Consumption Figures in Kw. Hrs. per ton

State	Alfalfa		Corn fodder carrying corn		Kafir wheat			Soy Bean Hay 1/4" 1st ch.		Lairy feed	
	Med.	Coarse	Fine		Fine	Med.	Coarse	Fine	Chaff'g	Coarse	
Alabama											
Illinois	18.7							39.2	5.7		
Kansas		6.54	21		19.5	12	7.5				
Averages	18.7	6.54	21		19.5	12	7.5	39.2	5.7		

* (Oats, jerked corn, and alfalfa)

Conclusions

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FEED GRINDINGA - GRAINEnergy Consumption Figures in Kw. hrs. per ton

State	Shelled Corn		Ear Corn		Oats and Barley		
	Burr Mill		Burr Mill		Burr or	Hammer	Roller
	fine	med.	fine	med.	Attrition	Mill	Mill
					fine med. coarse	fine	coarse
Illinois		2.3		9*		5.4	
Kansas		4.					
Minnesota			23.4	6.4	9.4		
Nebraska	10.0						
Oregon	11.8				14.2		3.2
Wisconsin		4.6			18**	5.4	32
Averages	10.9	3.6	23.4	7.7	18 11.8	5.4	32
							3.2

* (Sappy)

** (Estimated)

Energy Consumption Figures in Kw. hrs. per ton (continued)

	Wheat and Rye		Dairy Feed		Poultry Feed
	Burr	Hammer	Burr	Hammer	
	Mill	Mill	Mill	Mill	
	fine	fine	med.	coarse	
Alabama				6	
Minnesota			13.8***		
Nebraska			8		
Washington					20****
Wisconsin	9	10.0			
Averages	9	10.0	10.9	6	20

*** (Oats and barley)

**** (Wheat and oats)

B- ROUGHAGEEnergy Consumption Figures in Kw. hrs. per ton

	<u>Alfalfa</u>		<u>Corn Fodder</u> <u>carrying corn</u>	<u>Kafir butts</u>			<u>Soy Bean Hay</u> 1/4" lgth.	<u>Dairy Feed</u>	
<u>State</u>	<u>Med.</u>	<u>Coarse</u>	<u>Fine</u>	<u>Fine</u>	<u>Med.</u>	<u>Coarse</u>	<u>Fine</u>	<u>Chaff'g</u>	<u>Coarse</u>
Alabama									6*
Illinois	18.7						29.2	5.7	
Kansas		6.54	21	19.5	12	7.5			
Averages	18.7	6.54	21	19.5	12	7.5	29.2	5.7	6

* (Oats, jerked corn, and alfalfa)

FEED GRINDING

Energy Consumption Figures in Kw. hrs. per ton

State	Shelled Corn Butt Mill fine med.	Bar Corn Butt Mill fine med.	Bar Corn Attrition fine med. coarse	Oats and Barley Hammer fine	Roller Mill coarse
Alabama	2.3	9*	5.4		
Illinois	4.				
Indiana	10.0	23.4 8.4	9.4		
Iowa	11.8		14.2		3.2
Kansas	4.8	18**	5.4	32	
Michigan	10.2	23.4 7.7	18 11.8	5.4	3.2
Minnesota	3.8			32	
Missouri					
Nebraska					
North Dakota					
Ohio					
Oklahoma					
South Dakota					
Texas					
Virginia					
Washington					
West Virginia					
Wisconsin					
Wyoming					

Energy Consumption Figures in Kw. hrs. per ton (continued)

State	Wheat and Rye Butt fine	Hammer fine	Dairy Feed Butt fine	Hammer fine	Poultry Feed
Alabama	9	10.0	8	13.8***	20
Illinois	9	10.0	8	13.8***	20
Indiana	9	10.0	8	13.8***	20
Iowa	9	10.0	8	13.8***	20
Kansas	9	10.0	8	13.8***	20
Michigan	9	10.0	8	13.8***	20
Minnesota	9	10.0	8	13.8***	20
Missouri	9	10.0	8	13.8***	20
Nebraska	9	10.0	8	13.8***	20
North Dakota	9	10.0	8	13.8***	20
Ohio	9	10.0	8	13.8***	20
Oklahoma	9	10.0	8	13.8***	20
South Dakota	9	10.0	8	13.8***	20
Texas	9	10.0	8	13.8***	20
Virginia	9	10.0	8	13.8***	20
Washington	9	10.0	8	13.8***	20
West Virginia	9	10.0	8	13.8***	20
Wisconsin	9	10.0	8	13.8***	20
Wyoming	9	10.0	8	13.8***	20

Energy Consumption Figures in Kw. hrs. per ton

State	Alfalfa Med. Coarse	Corn Podder carrying corn fine	Kafir butte fine med. coarse	Boy Bean Hay 1/2" chop fine	Dairy Feed Coarse
Alabama	18.7	21	19.5 12	29.2	8*
Illinois	18.7	21	19.5 12	29.2	8*
Indiana	18.7	21	19.5 12	29.2	8*
Iowa	18.7	21	19.5 12	29.2	8*
Kansas	18.7	21	19.5 12	29.2	8*
Michigan	18.7	21	19.5 12	29.2	8*
Minnesota	18.7	21	19.5 12	29.2	8*
Missouri	18.7	21	19.5 12	29.2	8*
Nebraska	18.7	21	19.5 12	29.2	8*
North Dakota	18.7	21	19.5 12	29.2	8*
Ohio	18.7	21	19.5 12	29.2	8*
Oklahoma	18.7	21	19.5 12	29.2	8*
South Dakota	18.7	21	19.5 12	29.2	8*
Texas	18.7	21	19.5 12	29.2	8*
Virginia	18.7	21	19.5 12	29.2	8*
Washington	18.7	21	19.5 12	29.2	8*
West Virginia	18.7	21	19.5 12	29.2	8*
Wisconsin	18.7	21	19.5 12	29.2	8*
Wyoming	18.7	21	19.5 12	29.2	8*

(Oats, jerked corn, and alfalfa)

FEED GRINDING

A - GRAIN

The material at present available on feed grinding is not very conclusive, mainly because of two problems which had not been solved at the time it was taken, viz.:

1. Some definite and general method of measuring fineness.
2. Desirable degree of fineness from the feeding standpoint.

The project directors doing feed grinding work have recently worked out a fineness modulus based on the use of a mechanical shaker and 6, 10 and 20 (?) mesh sieves, the sum of the percentages retained on the three screens divided by 100 being the modulus in any particular case. With this as a basis more definite energy consumption figures will be available at an early date from at least Wisconsin and Oregon.

Purdue University is doing some work to determine the most profitable degree of fineness to grind grains, but data have not yet been released.

Energy Consumption

The energy consumption of course varies tremendously with the degree of fineness but where the grain is ground moderately fine, a little finer than medium as generally thought of, the energy consumption per ton will be around 20 Kw. hrs. for oats or barley, 10 Kw. hrs. for rye or wheat, and 5 Kw. hrs. for shelled corn. For ear corn the consumption will be about twice as high as for shelled corn.

Where the farmers are grinding dairy feed the energy consumption will usually range from 6 to 10 Kw. hrs. per ton, according to figures from practical farmers. In the case of poultry, this will be about 20 Kw. hrs. per ton.

In a representative case in Minnesota a farmer used an average for the year of about 16 Kw. hrs. per month for each 10 cows. In another case a farmer used about 5.7 Kw. hrs. for each 10 feeders, about one-third as much as for cows. In one case in Washington a poultryman grinds from $\frac{1}{2}$ to 1 lb. of feed per bird per

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month, using say 5 to 10 Kw. hrs. per month per 1000 birds. These figures indicate roughly what may be expected under present farm conditions.

Factors affecting energy consumption per ton

(a) First and foremost is, of course, fineness, there being a variation of at least 10 or 15 to one in the consumption for the same kind of grain.

(b) The sharpness of the burrs is extremely important in determining the efficiency of burr mills. In an extreme case in Wisconsin it took 24 times as much power with dull as with sharp burrs.

(c) Cob crushers, if not covered with a board or other protection, will materially increase the energy requirements for small grains or shelled corn.

(d) Many other factors, such as too slow or too high speed for the machine, type and make of mill, burr clearance and throat opening, (the latter two because of their influence on fineness, especially the latter), are also determining factors worth considering.

Types of Mills

(A) Burr Mills

The burr mills are cheap in first cost but do not lend themselves readily to automatic grinding without quite elaborate protection. They are well adapted to any type of grinding.

(B) Attrition Mills

Attrition mills are quite similar to burr mills but both burrs rotate. They are, of course, more expensive than burr mills but will do a little more economical job of fine grinding.

(C) Roller Mills

Roller mills are not so expensive as most hammer mills but are more so than burr mills. They do not require so much attention as burr mills and would therefore require less elaborate protection, when used automatically, than the latter. They are adapted only to rather coarse grinding.

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(D) Hammer Mills

Hammer mills are rather expensive but are well adapted to automatic control with a minimum of protection and will do feed grinding to any degree of fineness economically.

In this connection it is interesting to note that only recently a hammer mill has been developed in Chicago which can be operated very successfully with 2 H. P. or even 1 H. P. It will sell for the same price as burr mills of like capacity or even less, is quite rugged, can be automatically fed from a bin, and is apparently considerably more efficient than mills now on the market. Energy consumption data will be available at an early date.

Conclusions

The general indications that coarsely ground or cracked grains are just as economical to feed as medium ground, and considerably more so than finely ground, when grinding costs are considered, would seem to indicate that the consumption figures given under "energy consumption" are about 50% higher than necessary. This of course does not apply to feed grinding for poultry.

As soon as the new hammer mill developed in Chicago is generally available, it and similar machines which probably will be developed will undoubtedly replace present types at an early date.

B - ROUGHAGE

There is considerable disagreement as to the feasibility of grinding roughage for cattle and sheep. In general it seems to be agreed that cattle can be made to eat practically all of the hay when it is properly ground or chaffed, whereas they will leave about 20% of ordinary hay. However, if the hay is of good quality very little will be left under any circumstances.

Energy Consumption

"Finely ground" in the case of roughage of course does not mean anywhere near as fine as "fine" in the case of grain. In general it may be said that it will take about 29 Kw. hrs. to grind finely a ton of soy bean hay, 19.5 Kw. hrs.

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to grind kafir butts, 18.7 Kw. hrs. for alfalfa, and around 21 Kw. hrs. for corn fodder with the corn on it. Roughly it might be said that alfalfa, kafir butts, and corn fodder with the corn will take about 20 Kw. hrs. per ton, and soy bean hay around 30 Kw. hrs. per ton.

Where hay is chaffed or the roughage coarsely ground, the energy consumption will be around 5 to 7 Kw. hrs. per ton. Coarsely ground roughage is probably fine enough to induce the cattle to clean it up.

Factors Influencing Energy Consumption

(a) The most important factor in determining the energy consumption per ton is the fineness of grinding. However, even though coarsely ground feed is fine enough for cattle, it should be more finely ground for sheep. It will take, roughly, four times as much energy per ton to grind roughage fine as to grind it coarse, probably twice as much to grind for sheep as for cattle.

(b) The screen on the recutter on large roughage grinders seems to be of very little service, but very materially increases the energy consumption per ton.

(c) Dull knives will increase the energy consumption per ton, as compared to sharp knives, by about 100%.

(d) In a typical case it was found that it took one-third more power to operate a machine with a blower than without, when sharp knives were used; 25% with average knives.

Conclusions

It seems certain that it will not pay to grind roughage except rather coarsely, and even then it may not pay where roughage is quite cheap or power high. In order to overcome the large investment necessary, because of high priced labor, with the large machine deemed essential with hand feeding, it is very important that an automatic or semi-automatic machine be developed. Kansas is working on this problem. Unless some such machine is developed, roughage grinding probably will not prove practical in most sections. It is receiving the same criticisms

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as the silo. For the dairymen in the South, where roughage is rather high in price and grain comparatively cheap, a limited amount of roughage grinding is almost a necessity.

GRAIN AND FEED MIXING

Considerable interest in feed and grain mixing has been shown in New Hampshire and New York. In New Hampshire, a feed mixer of the augur type has been developed in cooperation with the Lane Manufacturing Company, which will thoroughly mix any kind of grain or feed and even cod liver oil. This mixer has a capacity of about 1500 lbs. per hour and it is thought that a 1 H. P. motor will operate it. No operating data are available.

On the Virginia project a feed mixer manufactured by the Robinson Manufacturing Company of Muncie, Indiana, is being tried out, but no operating data are as yet available.

In New York the subject is being studied in connection with feed grinding. A perforated rotating cylinder type of mixer is being built which will be tested at the New York State College of Agriculture, at an early date. This type of mixer has proven very practical on at least one southern dairy farm. A mixer of this type with a capacity of 6 tons per hour should not require over 1/4 H. P. to operate and the machine should not cost the farmer more than \$100.00 complete. It will mix anything, and do a thorough job.

HORSE AND COW CLIPPERS

An electric clipper will help to keep the horses and cows more sightly and comfortable, and in the case of the cows will be of assistance in producing better milk. There should be ample convenience outlets in the cow and horse barns so that it can be conveniently used.

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first cost. However, there seems to be no real reason why an ordinary barber's clipper would not prove satisfactory and usually they can be purchased for 25 to 30 per cent of the price of animal clippers. These, of course, could not be used to shear sheep but in most cases this would not be one of the requirements.

INCUBATION

The costs given below include oil at 18 cents per gallon, electricity at 3 cents per kilowatt-hour, and labor at 30 cents per hour. The labor costs cover only the additional labor required to operate the oil machines. Figures are based on 1000 eggs.

ELECTRICALLY HEATED AND VENTILATED INCUBATORS

	<u>150 eggs and less</u>	<u>151 to 300 eggs</u>	<u>301 to 600 eggs</u>	<u>1000 to 1500 eggs</u>	<u>6000 eggs</u>	<u>13,000 to 15,000 eggs</u>
<u>State</u>	<u>Kw. hrs.</u>	<u>Kw. hrs.</u>	<u>Kw. hrs.</u>	<u>Kw. hrs.</u>	<u>Kw. hrs.</u>	<u>Kw. hrs.</u>
Alabama				110		
California			110			
Idaho		140		234		
Indiana	169	154		118	32	16.4
Iowa		136				
Kansas	150			147		
New York		78				
Oregon			140			25.0
Washington		113	109			31.5
Wisconsin	218	230				
Average	<u>179</u>	<u>142</u>	<u>120</u>	<u>152</u>	<u>32</u>	<u>24.3</u>
Current Cost	\$5.37	\$4.26	\$3.60	\$4.56	\$.96	\$.23

The very marked decrease in unit cost with the larger machines is surely worthy of note.

OIL HEATED INCUBATORS

	<u>150 eggs and less</u>	<u>151 to 300 eggs</u>	<u>300 to 600 eggs</u>
<u>State</u>	<u>gallons of oil</u>	<u>gallons of oil</u>	<u>gallons of oil</u>
Kansas		30	
Oregon			20
Wisconsin	25		
Average	<u>25</u>	<u>30</u>	<u>20</u>
Cost of oil and additional labor	\$10.80	\$8.55	\$5.18

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ELECTRICALLY HEATED AND VENTILATED INCUBATORS

State	150 eggs and less	151 to 300 eggs	301 to 600 eggs	1000 to 1500 eggs	8000 eggs	13,000 to 15,000 eggs
	Kw. hrs.	Kw. hrs.	Kw. hrs.	Kw. hrs.	Kw. hrs.	Kw. hrs.
Alabama			110	110		
California		140		224		
Idaho		154		118	32	16.4
Indiana	168	138				
Iowa				147		
Kansas	150					
New York		78				
Oregon			140			22.0
Washington		113	109			31.8
Wisconsin	218	230				
Average	178	142	120	152	32	24.3
Current Cost	\$5.27	\$4.28	\$3.80	\$4.56	\$4.36	\$4.23

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OIL HEATED INCUBATORS

State	150 eggs and less	151 to 300 eggs	300 to 600 eggs
	Gallons of oil	Gallons of oil	Gallons of oil
Kansas		30	
Oregon			20
Wisconsin	28		
Average	28	30	20
Cost of oil and additional labor	\$10.80	\$8.55	\$5.18

OIL HEATED, ELECTRICALLY VENTILATED INCUBATORS

State	2,000 eggs		12,000 eggs	
	gallons of oil	Kw. hrs.	gallons of oil	Kw. hrs
Idaho	20.4	22.4		
Indiana	14.9	15.0		
Kansas	16.8	16.0	4.3	9.42
Average	17.4	17.8	4.3	9.42

Cost of fuel,
electricity, and additional labor \$5.13 \$1.55

The electric machines are cheaper to operate on the average than either the oil heated, or oil heated, electrically ventilated incubators. With cheaper oil the situation might be reversed.

The future popularity of the electric incubator on the farm depends to a large extent upon the continuity of service. However, as many eggs are now hatched in hatcheries located in small towns or cities where the service is very dependable, and as this practice appears to be on the increase, it is possible that the farm incubator may become of minor importance within the next few years.

The energy consumption of electrically heated machines is extremely variable, ranging on the average from 179 Kw. hrs. per hatch per 1000 eggs in the small machines of 150 egg capacity or less, to around 24 Kw. hrs. in the large 15,000 egg machines.

Good insulation is very important in determining the energy consumption. For instance, one well insulated machine of 200 egg capacity had a consumption of 78 Kw. hrs. per hatch per 1000 eggs as compared to 142 Kw. hrs. for the average. Insulation is of especial importance on the rural line where the power is apt to be off for longer periods than in the cities and towns.

Important Considerations for the Incubator

(a) Every incubator should be equipped with a no-voltage or a temperature alarm, the latter being somewhat better as it gives additional protection against thermostat trouble. When the power goes off, the farmer or poultryman can immediately close the ventilators and cover the machine with blankets so that the

OIL HEATED, ELECTRICALLY VENTILATED INCUBATORS

12,000 eggs		2,000 eggs	
gallons	Kw. hrs.	gallons	Kw. hrs.
4.3	9.42	20.4	22.4
4.3	9.42	14.9	15.0
		18.8	18.0
		14.4	14.8

State
Ohio
Indiana
Kansas
Average

Cost of fuel,
electricity, and
additional labor

\$1.56

\$5.13

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The energy consumption of electrically heated machines is extremely variable, ranging on the average from 175 Kw. hrs. per hatch per 1000 eggs in the small machines of 150 egg capacity or less, to around 24 Kw. hrs. in the large 15,000 egg machines.

Good insulation is very important in determining the energy consumption. For instance, one well insulated machine of 200 egg capacity had a consumption of 18 Kw. hrs. per hatch per 1000 eggs as compared to 142 Kw. hrs. for the average. Insulation is of especial importance on the rural line where the power is apt to be off for longer periods than in the cities and towns.

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(a) Every incubator should be equipped with a no-voltage or a temperature alarm, the latter being somewhat better as it gives additional protection against thermostat trouble. When the power goes off, the farmer or poultryman can immediately close the ventilators and cover the machine with blankets so that the

radiation losses will be lowered to a minimum. Power interruptions of 8 or 9 hours have occurred without resulting in serious damage. However, if the eggs have been but recently set, or the chicks are just coming out of the shell and, as a consequence, are wet, there is apt to be a considerable loss if the power is off too long.

(b) There is considerable disagreement as to the advisability of having auxiliary heat for emergencies. There is considerable danger of "spotty" heating, especially where the machine is electrically ventilated, and in such cases the losses would be much greater than if the eggs had been merely chilled. The emergency heating system is usually quite expensive, and the danger of loss is so remote, with proper alarms, that the extra investment would hardly seem advisable, certainly not on the forced ventilation types.

An Oregon hatchery at the end of an 80 mile transmission line has an individual lighting plant for emergency use, but even there it is seldom used.

(c) In the smaller machines so much labor in caring for the lamp on the oil heated machine is avoided through the use of the electrically heated machine, that the latter is far more economical to operate when the labor is considered. With the larger machines there is usually very little difference in operating costs.

(d) Moisture is so important in determining the number of fertile eggs which hatch that probably it would not be very hard to estimate the average humidity held by the machine from the percentage of hatches obtained. In Oregon it was found that where the humidity was kept up, the hatching percentage of the different machines did not differ materially. However, it undoubtedly would be quite difficult for the average farmer to maintain the proper humidity in at least one or two of the most popular machines now on the market. This may explain a lot of the poor hatches that are obtained. With a machine like the Petersime it is not difficult to maintain a humidity of around 60 to 65%.

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found that where the humidity was kept up, the hatching percentage of the
erent machines did not differ materially. However, it undoubtedly would be
e difficult for the average farmer to maintain the proper humidity in at least
or two of the most popular machines now on the market. This may explain a lot
the poor hatches that are obtained. With a machine like the Petersime it is
difficult to maintain a humidity of around 60 to 65%.

(e) In Idaho it was found that it took about 67% more time, on an egg unit basis, to care for an oil heated and electrically ventilated machine with a capacity of around 2,000 eggs where the eggs had to be turned by hand, than it did to care for an electrically heated machine with a capacity of around 1,400 eggs where the eggs were turned by merely rotating a drum 90 degrees.

(f) It is generally found advisable to have an electrically heated machine equipped with an average of $1\frac{1}{2}$ watt per egg in heating elements.

(g) Thermostats are the heart of an incubator. They should be very sensitive, keeping the maximum temperature variation below .5°F. from the setting. The more current which the points must handle the more chance there is for trouble. Some large machines, such as the 6,000 and 15,000 egg Petersimes, which have more than one heating element and thermostat in parallel, are reasonably secure from serious trouble if carefully watched. However, a number of the smaller machines of various makes have given trouble and probably will continue to do so.

A pendulum type mercury switch thermostat which has been put out by the Cyphers Incubator Co. of Buffalo seems to be at least a step in the right direction. It is quite sensitive and with a relay could handle any amount of energy.

An interlocked thermostat manufactured by the Buckeye Company also looks promising when the "bugs" are worked out of it.

(h) The Cyphers Incubator Co. is making a special study of incubator fundamentals, such as humidity, and should find some of the more important factors in incubation. This same company has a very well insulated 204 egg machine which can be used singly or for building up a deck type mammoth. They are now working on a drum type mammoth, 600 eggs per unit, which will be so compact that the machine apparently will need ventilation rather than heat after the first few days.

INCUBATOR CELLAR HEATING

In 1926 the temperature in the Oregon Agricultural College incubator cellar was kept from dropping too low by installing a 500 watt heater in the lower

(e) In Idaho it was found that it took about 67% more time, on an egg basis, to care for an oil heated and electrically ventilated machine with a capacity of around 2,000 eggs where the eggs had to be turned by hand, than it did care for an electrically heated machine with a capacity of around 1,400 eggs where the eggs were turned by merely rotating a drum 90 degrees.

(f) It is generally found advisable to have an electrically heated machine equipped with an average of $1\frac{1}{2}$ watt per egg in heating elements.

(g) Thermostats are the heart of an incubator. They should be very sensitive, keeping the maximum temperature variation below 5°F . from the setting. More current which the points must handle the more chance there is for trouble. Large machines, such as the 6,000 and 16,000 egg Peterlins, which have more than one heating element and thermostat in parallel, are reasonably secure from serious trouble if carefully watched. However, a number of the smaller machines various makes have given trouble and probably will continue to do so.

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INCUBATOR CELLAR HEATING

In 1928 the temperature in the Oregon Agricultural College incubator cellar was kept from dropping too low by installing a 600 watt heater in the lower

end of each of two 6" pipes suspended from the ceiling on one side of the room. These pipes were open at both ends and the air currents which naturally developed kept the air in the cellar circulating and prevented any stagnant corners with low temperatures. The operation of the heaters was entirely successful.

B R O O D I N G

State	Sq.in. per chick	Type of Brooder	Number of Chicks	Outside Temp. Range	Temp. Aver. deg.F.	Brooder Wattage	Watts per Chick	Per ct. of time on	Kw. hrs. per 40 wk. season range....aver.
Calif.	3.77	Blackheat	915		55*	780-913	.925	30.9	.230-.412 .315
Calif.	7.9	"	364		55*	670-1300	2.7	26.6	.462-.74 .581
Ind.	4.95	"	283	0-75*	55*	500	1.77	99	2.35
Iowa	9.00	"	200		70*	300	1.5		.45
Kansas		"	100	42-50	46				1.85-2.36 2.
Ore.	7.5*	Kable fresh air	350		50-60*				.448
N. Y.	20	Blackheat insulated	50	40-80	70	300	3	30	.70

* (estimated)

Comparative Operating Costs of Different Types of Brooders
(Oregon)

Brooder	No. Chicks	Wt. per 100 Chicks	At End of 3rd Week		
			Fuel used per chick	Price unit	Fuel cost per chick
Coal heated	350	21.75	1.25 lbs.	\$17.00 ton	1.06¢
Oil heated	350	24.25	.097 gal.	.18 gal.	1.74¢
Electric underheat	500	26.38	.413 kwh.	3-1/2¢ Kwh.	1.45¢
Lyons Electric	350	25.87	.406 kwh.	3-1/2¢ Kwh.	1.42¢
Fresh Air Electric (Kable)	350	27.19	.448 kwh.	3-1/2¢ Kwh.	1.57¢

The fresh air electric brooder costs 48% more than the coal and 11% less than the brooder, for heating energy.

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B R O O D I N G

Rate	Sp. in. Type	Number of	Aver. Temp.	Brooder	Watts	Per of	Kw. hrs. per
chick	per of	Chicks	Range	per of	chick	time	40 wk. season
.....							
11.7	3.75 Blackhead	315	55*	780-915	.925	30.3	.230- 415
11.7	7.5	364	55*	670-1300 2.7	.26	26.6	.462- 74
4.4	4.95	283	55* 0-75*	500	1.77	99	2.25
9.00	"	300	70*	300	1.5		.45
100 42-50	"	100	45				1.85- 2.35
7.5*	Kable	350	50- 60*				.445
Y. 20	Blackhead 50 40-50 insulated	50 40-50	70	300	2	30	.70

(estimated)

Comparative Operating Costs of Different Types of Brooders (Graham)

Brooder	No. Chicks	Wt. per 100 Chicks	Fuel used per chick	Price unit	Fuel cost per chick
al heated	350	21.75	1.25 lbs.	\$17.00 ton	1.085
l heated	350	24.25	.097 gal.	.18 gal.	1.745
electric underheat	500	26.38	.413 kWh.	3-1/2¢ kWh.	1.455
ons Electric	350	25.87	.406 kWh.	3-1/2¢ kWh.	1.425
ash Air Electric	350	27.19	.448 kWh.	3-1/2¢ kWh.	1.575
(Kable)					

fresh air electric brooder costs 48% more than the coal and 11% less than the brooder for heating energy.

Comparative Operating Costs of Different Types of Brooders
(California)

Brooder	No. of Brooders	Average Sq. in No. of Chicks	per Chick	Fuel cost Per unit	Fuel used per chick 5 wks. & 4 days		Aver. cost
					Range	Average	
Electric	4	95.2	16.1	4¢ kwh.	.31-1.51	1.11	4.44¢
Oil	3	95.3	22.3	16¢ gal.	.3 - .34	.314	5.2¢

None of the variations seemed to follow well defined tendencies. They were therefore given as averages. The hover areas were large and resulted in high consumption. The operating cost per chick was 17% higher with oil.

Comparative Operating Costs of Different Types of Brooders
(Indiana)

Brooder	Sq. inches Per Chick	No. of Chicks	Fuel used per chick per season
Electric	4.95	283	2.35 Kw. hrs.
Coal	4.95	283	3.85 lbs.
Oil	4.95	283	.22 lbs.

The consumptions obtained from the various states vary considerably with the conditions, ranging from .3 to 2.35 Kw. hrs. per chick per season.

Factors affecting energy consumption

(a) The areas per chick under the hover is one of the most important factors in determining the energy consumption per chick. For instance, it will take only about half as much energy where 3.5 sq. in. are allowed per chick as compared to 7 or 7.5 sq. in.

(b) The use of insulation on the brooder will materially lower the consumption, as can readily be seen by the data from New York, when the area per chick is taken into consideration.

(c) The temperature in the brooder house will of course very materially affect the energy consumption. No data are available, but it is quite likely that the consumption of a 6 ft. insulated brooder would not be much more than doubled by a drop of 70° to 0°F. assuming insulation equivalent to one layer of celotex.

Comparative Operating Costs of Different Types of Brooders
(California)

Brooder	No. of Brooders	No. of Chicks	Average Sp. in per Chick	Fuel cost Per unit	Fuel used per chick 5 wks. & 4 days	Average	Aver. cost
Electric	4	98.2	16.1	4¢ kWh.	.31-1.51	1.11	4.44¢
Gas	3	95.3	22.3	18¢ gal.	.3 - .34	.214	5.2¢

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(d) Automatic temperature control has been found by Petaluma poultrymen to reduce their energy consumption, as compared to manual control, by 15 to 20%.

Conclusion

With the above suggestions incorporated in a 6 foot brooder it is likely that the energy consumption could be kept below .5 Kwh. per chick season in a well built brooder house assuming the temperature to drop no lower than 0°F. inside the house.

Important Brooding Considerations to the Poultryman

(a) Every brooder should be equipped with a no-voltage or temperature alarm to notify the poultryman when the power goes off so that he can take any steps necessary, such as placing blankets over the hover, etc. to conserve the heat. Interruptions of 8 or 9 hours have occurred without serious damage to the chickens where the farmer acted promptly. A temperature alarm is to be preferred as it will also give warning should the thermostat, points refuse to function.

(b) The temperature regulator on the brooder does not need to be very sensitive, a range of 5°F. or even more being permissible. When considerable energy must be handled, a relay should also be used or the contacts will give trouble, 300 watts being about the limit of safety unless the points are carefully cleaned at regular intervals. A condenser in parallel will prevent the fusing but not corrosion of the points. In a large, well built brooder house one thermostat and a relay might easily take care of a whole battery of hovers.

(c) If the temperature of the brooder house is apt to drop down to around -10°F. the 5 ft. or 6 ft. well insulated brooder should not require over 2 watts per chick, where the chicks are given but 3.5 sq. in. of hover floor space. This is on a basis of day-old chickens. This would seem quite crowded but at least one poultryman has found this small area per chick very practical by selling his cockerels at 3 or 4 weeks for friers.

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Conclusion

With the above suggestions incorporated in a 6 foot brooder it is like-
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chickens at 3 or 4 weeks for fliers.

(d) In a test at Schenectady, New York, it was found that almost 50% of the energy for brooding was consumed during the first week and around 80% during the first two weeks of operation, that is, with thermostatic control and temperature reductions as the chicks get older. This seems a little high but is indicative of the general situation.

(e) It has always been considered very bad for baby chickens to be in a damp house, but some work in Indiana during 1926 would seem to cast doubt upon this conclusion. An electric brooder was used in a brooder house without auxiliary heat during the cold weather with the result that the walls and litter were always damp or wet. However, these chickens weighed more and were more vigorous than a similar group taken care of by a coal brooder. The chickens came out and ate, ran back under the hover when they got cool, and then came out and ate again. It was really the open front brooder system adapted to electric heating.

(f) Types of Brooders

One poultryman in New Hampshire has installed electric brooders in a brooder house having a hot air furnace as a source of auxiliary heat.

There has been a tendency in the western states to place a heavy layer of sand, (2 inches), under the brooder as a heat reservoir. In Idaho, brooders have been built which carry this idea still further, a brick furnace being built in a pit and the chimney or flue pipe laid in a long trench, (as long as needed), and 10 or 12 inches of sand then placed over the pipe. The hovers are then placed over the sand. It generally takes 2 or 3 days to heat the sand, but after that the poultryman's heating troubles are about over as the large heat storage capacity makes it practical for the furnace to be fired once or twice daily without a temperature regulator. This brooder is very efficient. Such a system would seem to have most of the desirable features of the electric hover plus the low operating costs of the coal or wood heater. Its first cost is also very much in its favor. It would seem to be very practical for the large poultrymen in colder climates.

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The coal or wood stove brooder is not very satisfactory when it must be operated at low capacity as is the case in warm weather.

The under-heat brooder has proven very economical to operate and has worked very successfully in its first year of trial. It was developed by the Western Washington Experiment Station and the Puget Sound Power & Light Company, and a number of them have been sold. Its departure from the conventional overhead heat seems to have been a success in keeping the brooder dry with much lower energy consumption than previously had been found practicable. The chicks are on 2 inches of sand.

In California they are working on an improved radiant type of brooder. They are trying to get an even distribution of heat under the hover, (not true of present types), and lower coal temperatures by lowering the coil height above the floor. This would greatly lengthen the coil life and improve the brooder efficiency.

The fresh air brooder designed by Professor Kable at Corvallis, Oregon, seems to be a very successful attempt to keep the hover dry with low energy consumption. The air is recirculated. The brooder has proven very satisfactory. Its construction is better than most brooders from at least one standpoint as it is actually fireproof. Since the heating units are separate, they could be purchased and put into older types of brooders by the farmer himself.

There is need for further investigation work upon brooders.

ULTRA VIOLET LIGHT

1. Children

There would seem to be no reason why an ultra violet lamp could not be used to prevent or cure rickets in children just as it does with baby chickens. They could be allowed to play under the light a certain length of time each day.

2. Poultry (a) Quite a bit of work has been done by Professor Hughes of Kansas on the effect of ultra violet light upon chickens. According to Professor Hughes,

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effect of ultra violet light upon chickens. According to Professor Hughes;

15 minutes daily treatment with the Uviarc lamp, 8 hours treatment with the Cooper-Hewitt Factory lamp, 4 or 5 hours treatment with direct sunlight, 1/2 per cent of cod liver oil in the feed or milk treated for 30 minutes with ultra violet light and then fed at the rate of 5 c.c. per day will produce normal growth, but there is no certainty that these specifications represent minimum requirements. It is merely a matter which each farmer or poultryman must work out for himself in order to determine the most practical plan under his conditions. One farmer solved the problem by exposing the feed in the feed hoppers to the sunlight, the eaves of the chicken house protecting the feed from the rain.

(b) It was found in Minnesota that 1,000 baby chickens can be given sufficient treatment by exposing them to the rays for about one-half hour. The lamp was about 3 ft. above the ground and directly over the feed hopper, the latter being opened as the light was turned on. Since the lamp can be moved about five times it would seem practical to use one lamp for approximately 5,000 chickens. Only one resistor will be necessary if the leads are long enough so that it will not be necessary to move it. Since the resistor is rather heavy and relatively inexpensive it would be advisable to have enough of them to avoid moving them around.

In a similar way it was found that by hanging the lamp between the feed hopper and the drinking fountain and leaving it on for two hours at a time, 300 hens could be successfully treated at one time, the scratch grain being scattered under the lamp as far as practical when the lamp was lighted. If a wet mash is fed at noon, 900 hens could be treated with one lamp under this plan.

Energy Consumption

Although the most important consideration in operating an ultra violet lamp is the high first cost and rapid depreciation, the energy consumption is, nevertheless, important. It will take about 7.5 kw. hrs. per month per 1000 baby chickens treated, one month's treatment generally being sufficient. In the case

minutes daily treatment with the Uviate lamp, 8 hours treatment with the Cooper-Hewitt lamp, 4 or 5 hours treatment with direct sunlight, $1\frac{1}{2}$ per cent of cod liver oil in the feed or milk treated for 30 minutes with ultra violet light and then fed at the rate of 5 c.c. per day will produce normal growth. There is no certainty that these specifications represent minimum requirements. It is merely a matter which each farmer or poultryman must work out for himself in order to determine the most practical plan under his conditions. One farmer solved the problem by exposing the feed in the feed hoppers to the sunlight, the eaves of the chicken house protecting the feed from the rain.

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of hens it will take about 100 Kw. hrs. per month per 1000 birds treated.

Significance

The use of ultra violet light and electric lights will enable the poultryman to buy June chickens, (the cheapest chickens of the year), and bring them into laying at the same time as those hatched two months earlier. The expense of raising chickens at this time of the year is very low, little equipment or heat being required. Ultra violet light is probably not very essential in midsummer, even for chickens being "pushed", and there are many substitutes for it. The long working days made possible by electric lights are undoubtedly very important under such circumstances. In 1926 a flock of late-hatched chickens were brought into early laying by the Adirondack Power & Light Corporation at Schenectady, New York, through the use of lights alone.

The Uviarc lamp would seem to offer the poultryman a convenient method of maintaining the vigor of his flock or the vitamin content of the eggs during the cold sunless days of winter when the birds must be kept in the house.

3. Sheep

In the spring of 1926 the sheep barn at the University of Washington burned down and destroyed the test flock of 40 ewes and testing equipment. Later, two ewes were secured for test purposes. One ewe, which was fed normal barley and hay, had a negative calcium balance at the end of ten days, whereas the other ewe fed the same ration after it had been treated with ultra violet light for 30 minutes at a height of 30 inches, had a positive calcium balance at the end of the ten days. When the rations were reversed the results were reversed.

It would seem that ultra violet light might be useful in treating the feed for ewes at lambing time and until they are turned out on pasture, at least till the lambs are weaned. It probably would result in more and better lambs and lower mortality among the ewes.

4. Hogs

The treatment of hogs with ultra violet light for 30 to 45 minutes daily

of hens it will take about 100 Kw. hrs. per month per 1000 birds treated.

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The treatment of hogs with ultra violet light for 30 to 45 minutes daily

on 113 consecutive days, at the Kansas State College of Agriculture, did not result in any observable differences in growth, development, and general vigor between the treated and untreated animals.

GREEN FEED CUTTING AND ROOT SHREDDING

Energy Consumption in Kw. hrs. per 100 lbs. cut or shredded

<u>State</u>	<u>Kale</u>	<u>Roots or Carrots</u>
Oregon	.31	.2
Washington	.07	

The successful poultryman must furnish considerable green feed for his chickens and the chopping of this feed requires considerable time and energy. For instance, in Washington it is generally recommended that from 8 to 10 lbs. of young kale (where kale is the green stuff fed) or 5 lbs. of more mature kale be fed daily per 100 laying birds. In each case it is assumed that the kale is chopped, since the chickens will waste, on the average, 40% of the unchopped and only 20% of the chopped kale.

Through some tests made in the State of Washington it was found that it took 5.6 as much man-labor 2.8 times as long to cut a given amount of kale with a hand-driven machine as with the same machine driven by motor. With labor at 30¢ per hour and energy at 3¢ per Kw. hr. the motor driven machine makes a saving of about \$3.65 per ton of kale cut.

In Oregon the use of a motor on a root shredder resulted in a saving of one man's labor and of 50% in the time required to shred a given amount of roots.

Energy Consumption, etc.

The energy consumption varies considerably with the efficiency and adaptability of the cutter, running from .07 to .31 Kw. hrs. per 100 lbs. for kale, and running around .2 Kw. hrs. per 100 lbs. of roots shredded in the Washington and Oregon tests. At most the energy consumption is comparatively small.

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Oregon	.31	2.
Washington	.07	

The successful poultryman must furnish considerable green feed for his

chickens and the chopping of this feed requires considerable time and energy.
For instance, in Washington it is generally recommended that from 8 to 10 lbs. of
young kale (where kale is the green stuff fed) or 5 lbs. of more mature kale be
fed daily per 100 laying birds. In each case it is assumed that the kale is
chopped, since the chickens will waste, on the average, 40% of the unchopped and
only 20% of the chopped kale.

Through some tests made in the State of Washington it was found that it
took 5.8 as much man-labor 2.8 times as long to cut a given amount of kale with a
hand-driven machine as with the same machine driven by motor. With labor at 30¢
per hour and energy at 3¢ per Kw. hr. the motor driven machine makes a saving of
about \$3.65 per ton of kale cut.

In Oregon the use of a motor on a root shredder resulted in a saving of
one man's labor and of 50% in the time required to shred a given amount of roots.

Energy Consumption, etc.

The energy consumption varies considerably with the efficiency and
adaptability of the cutter, running from .07 to .31 Kw. hrs. per 100 lbs. for
kale, and running around 2.5 Kw. hrs. per 100 lbs. of roots shredded in the
Washington and Oregon tests. At most the energy consumption is comparatively

A 1/2 H. P. motor will operate a small feed cutter at around 350 R. P. M., the cutter having a capacity of around 750 lbs. per hr. at this speed.

BONE GRINDING

One of the cooperating farmers of the Wisconsin Project has been buying bones from the butcher shop at \$1.00 per 100 lbs and grinding these bones for poultry feed.

A Mann No. 3 bone grinder was used with a 5 H. P. motor. The energy consumption has been 1.1 Kw. hrs. per 100 lbs. of ground bone. With this outfit the rate of grinding was between 100 and 150 lbs. per hour. This gives a grinding capacity ranging from 20 to 30 lbs. per hour per H. P. There are smaller bone grinders on the market.

OAT SPROUTERS

State	Kw. hrs.		Kw. hrs. per	
	Per Month	Per 100 lbs. of Sprouted Oats	1000 chickens	Wattage
Iowa	15	150	75	27
New Hampshire	318	600	300	880
Oregon	354*	550	225	
Washington	150	150	75	600

* February

The energy consumptions are, of course, only close approximations. The entire wattage in the case of New Hampshire and Washington would not be on except during rather cold weather.

Conclusions

An electrically heated sprouter will go a long way towards freeing the poultryman from the green feed worry. It will eliminate the fire hazard that always accompanies the use of oil. (One Iowa farmer had three lamp explosions before he converted his sprouter to electric heat).

For the heating of oat sprouters by electricity to become widely popular it would seem that a power rate of not over 3¢ per Kw. hr. would be necessary.

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If the oat sprouter is well insulated or is placed in a protected, warm location, the energy consumption should not be above 75 Kw. hrs. per month per 1000 birds. One bushel of sprouted oats will take care of 1000 birds (about 2 cu. in. per bird). In such a location a 125-watt element should take care of enough oats for close to 1000 chickens.

BURGLAR ALARMS

Due to a large amount of thievery, (largely of chickens along our main highways), there is real need for an effective burglar alarm that will not be too expensive.

General Discussion

There are several burglar alarm systems on the market which are of good quality but which are too elaborate and expensive for the average farm. Most of these are of the annunciator type.

A burglar alarm should work on the closed circuit principle, and the current through the solenoid or relay should be low enough so that it will require resetting by hand. In this way the alarm bell will continue to ring until it is reset, no matter how quickly the circuit is closed after being once opened. If the relay is self-setting, a constant ringing drop must also be used which, of course, adds to the cost. This is easily accomplished by placing the proper amount of resistance in series with the holding coil. Light bulbs make as cheap and effective a resistance as can be obtained for this purpose.

The alarm should be so arranged that no matter how the wires are tampered with, especially by "bonding" and "cutting", the system will still give the alarm. It is readily apparent that if the resistance is placed out of reach in the protected building, the bonding of the wires would short the holding coil of the relay and blow out the fuse in the relay circuit. This would, of course, give an alarm.

If the cat sprouter is well insulated or is placed in a protected, warm location, the energy consumption should not be above 75 Kw. hrs. per month per 100 birds. One bushel of sprouted oats will take care of 1000 birds (about 2 oz. per bird). In such a location a 125-watt element should take care of enough as for close to 1000 chickens.

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In case there is danger of the main light wires being cut, (not very likely), the batteries will have to be used in the secondary circuit to operate the alarm bell. However, the use of the light circuit has some obvious advantages, viz: no batteries are required, and a circuit can easily be installed in parallel with the resistance and alarm bell, so that the whole area of disturbance will be lighted immediately and automatically by a yard or searchlight when the alarm is given.

In case 110 volts is used in the secondary or alarm circuit, the series resistance should be high enough to protect the bell and yet low enough to operate it effectively. During the summer of 1926 the Adirondack Power & Light Corporation installed a burglar alarm to protect some instruments being used on an electric brooder test. In this case a 75 watt Mazda lamp, (about 160 ohms), was placed in series with an ordinary door bell. It worked very satisfactorily. In this same connection it may be of interest to note that a resistance of two 25 watt lamps in series, not far from 1000 ohms, was used in the primary coil circuit of a G. E. Type PQ 26 instantaneous under-voltage relay across 110 volts A.C. This reduced the demand to about 7 or 8 watts which, of course, was not prohibitive.

When it is desired to have the particular building being tampered with, indicated, a complete outfit should be installed for each building concerned, as annunciators are rather expensive. However, where there are a large number of buildings, an annunciator may be cheaper. In case one indicator is sufficient, all of the window and door switches in the different buildings can be placed in series.

The General Electric Company is putting a small 2 watt, 110 volt relay on the market which should prove very satisfactory for burglar alarm work and be quite inexpensive.

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Ithaca, New York, is making a study of burglar alarm systems and will publish a bulletin on the subject.

Conclusion

A thoroughly reliable and very effective burglar alarm, according to the above recommendations, could be installed at a cost for materials of about \$10.00. The wiring between the buildings would be extra, of course.

LIGHTS FOR EGG PRODUCTION

It is generally recognized that lighting poultry pens to give an average working day ranging from 12 to 13 hours from November 1 to March 1 will result in increasing the percentage of yearly egg production during this period. In the case of late maturing pullets it will often prove practical to use lights even earlier in the season. It is also generally agreed that the use of lights will not increase the total yearly egg production. In connection with rural electrification studies there has been work on this subject in three states---Minnesota, Oregon, and Virginia. In each of these cases the investigations were limited either as to time or other important factors, causing some doubt as to whether or not the results can be considered as typical. The Oregon data are summarized below. It should be noted that these studies extended only over the lighting period---October 1 to April 1.

The recommendations are summarized as follows:

1. The intensity of light on the feeding floor should be from eight-tenths (0.8) to one (1.0) foot candle.

2. The lighting will consist of one 40-watt Mazda lamp with cone-shaped reflector sixteen inches in diameter and four inches deep.

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LIGHTS FOR EGG PRODUCTION DATA TAKEN OCTOBER 1, 1925 to APRIL 1, 1926

	Number of Birds	Eggs	Value	Kw. hrs. 6 mos.	Cost of Feed & Light	Cost of Feed	In favor of Lights
Best pullets Lights	112	11,807	\$345.37	55	\$135.24		\$35.17
Best pullets No lights	115	10,617	298.79			\$123.83	
Less mature pullets - Lights	114	10,979	315.86	51	132.40		49.89
Less mature pullets-No lights	115	9,064	255.33			121.76	
Yearling hens Lights	197	5,213	152.51	108	191.72		
Yearling hens No lights	199	4,798	117.24			188.77	32.32*

* Reduced the loss by the amount shown.

OREGON DATA - OCTOBER 1, 1926 to APRIL 1, 1927

Income above feed and light

	Not lighted	Lighted	Increase
Early maturing pullets	\$156.14	\$216.62	\$60.48
Late maturing pullets	134.92	145.93	11.00
Yearling hens	48.07**	15.12	63.19

** Loss.

The requirements for the proper installation of lighting equipment for egg production have been carefully worked out by Professor F. L. Fairbanks of Cornell University and published in Cornell Extension Bulletin 90, Artificial Illumination of Poultry Houses for Winter Egg Production.

The recommendations are summarized as follows:

1. The intensity of light on the feeding floor should be from eight-tenths (.8) to one (1.0) foot candle.

2. The lighting unit consists of one 40-watt Mazda lamp with cone-shaped reflector sixteen inches in diameter and four inches deep.

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OREGON DATA - OCTOBER 1, 1925 to APRIL 1, 1927

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	Not lighted	Lighted	Increase
early maturing pullets	\$126.14	\$216.62	\$80.48
late maturing pullets	124.92	145.93	11.00
early hens	48.07**	15.12	63.19

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(8) to one (1.0) foot candle.

2. The lighting unit consists of one 40-watt Mazda lamp with cone-shaped

reflector sixteen inches in diameter and four inches deep.

3. Placed six feet from the floor this will light approximately 200 square feet of floor space. To find the number of lights required, divide the square feet of floor space by 200. The nearest whole number will be the number of units required.

4. If the poultry house is divided into pens, figure each pen separately.

5. Place the lighting units six feet from the floor and ten feet apart, along a line midway between the front of the house and the front of the dropping board.

6. For maximum efficiency, the dropping board should be three feet from the floor.

7. The reflecting surface should be covered with three coats of aluminum bronze paint.

8. The working day for the birds should be from twelve to thirteen hours.

9. Approximately three and one-half square feet of floor space is recommended per bird.

10. When an individual lighting plant is used to supply light for five hundred or more birds, the generator should be operated while the lights are on.

There is still a difference of opinion among poultry authorities as to whether lights should be used in the morning, at night, or at both times. In this connection it may be stated that the length of the working day appears to be the prime consideration unless the midnight lunch method of feeding is used. New Jersey has found this system just as effective as the other systems. It, of course, is not adapted to the all-mash method of feeding.

When lights are used in the morning, automatic operation can be secured by a time switch. Ordinary alarm clocks can be used for this purpose. When night lights are used, dimmers are desirable to get the chickens to roost properly, although some poultrymen do not use them. Different types of dimmers are described by Harry L. Garver in Popular Bulletin 134, Methods of Dimming Lights for Poultry Houses, published March 1926 by the State College of Washington, Agricultural Experiment Station, Pullman, Washington.

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There is urgent need to have all available literature on lighting for egg production digested, analyzed, and correlated.

WATER HEATING FOR POULTRY

Whenever the drinking fountains in the laying houses are frozen over, the chickens' working day is shortened accordingly. In fact, it is a waste of energy to use electric lights when the birds do not have free access to water. This brings up a problem of considerable importance to the poultrymen of the Middle West, during the cold snaps in the winter.

A study of electric heaters for poultry fountains has been made in Oregon and New York. Some 5 and 10 watt immersion heaters which were tested out at Ithaca, New York, proved to be inadequate. In Oregon, tests were made with heaters patterned after the ordinary flat heaters on which the drinking fountain is supposed to be placed, and with a special 75 watt immersion heater made by the Electric Heating Co. of Boston for Mr. Garver. This special heater proved to be about right from the standpoint of heating capacity and of course was more efficient than any of the non-immersion types.

An interesting outcome of the Oregon tests was the discovery that the chickens drank 25% more water in the houses with warmed water than in the houses without warmed water. When the weather was above freezing the difference was only 5%. These differences are quite significant since they really denote better appetites and, incidentally, more eggs.

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element and an ether wafer operated thermostat. The flat pan shaped drinking vessel rests in the top of the box, making the box practically airtight. With a relay any number of drinking fountains could be connected in parallel and the water in all kept at practically the same temperature. Such an outfit would enable the poultryman to have absolute control over the water temperatures and increase egg production accordingly. Such water heaters should not be very expensive for the man with a large flock. Any standard, moderate sized, brooder heating element could be used.

VACUUM CLEANERS FOR POULTRY HOUSES

A study of the use of large sized special vacuum cleaners for the removal of poultry house litter has been made in California and New Hampshire. In California it was found necessary to use rather a large motor - 5 H. P. The tests were not very satisfactory. If a cleaner is developed which will do this work satisfactorily it will fill a real need among poultrymen, as the removal of soiled litter represents a considerable portion of the time required to properly care for a flock of birds during that part of the year when they are not on the range.

VENTILATION AND LITTER DRYING IN POULTRY HOUSES

In foggy, damp weather the litter in chicken houses must be changed quite frequently, representing considerable expense for labor and straw. The Western Washington Agricultural Experiment Station made some tests to determine whether this could be remedied, at least in part, by ventilating the laying houses with heated air. The tests were not conclusive and will be continued.

Set-up and Cost

An oil brooder was placed in a fairly tight room at one end of the laying house and a pressure blower with a capacity of 600 to 700 cu. ft. of air per minute and operated by a 1/4 H. P. Motor, forced air through a 7-1/2" x 18" wooden duct under the dropping boards and near the back of the house, there being vents

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every few feet consisting of down-spout elbows. The back pressure at the far end of the line is compensated by the blower at optimum speed, just as in the case of the forced out enough additional air at the farther end to compensate (insofar as was observable) for the drop in temperature. As a result the litter was as dry at one end of the house as the other. The air was drawn into the blower from the top of the hover, flowing in from the outside through a trap door. None of the air was recirculated.

The estimated cost of the outfit, complete with labor and lumber, was close to \$100.00 per 1000 birds. This does not include the heater as the farmer generally has something around that can be used for this purpose. Furthermore, a suitable stove would be inexpensive.

Results

The litter was kept dry and it was not necessary to change it more than once every 30 days, when it was worn out. The litter in the other houses had to be changed every week or ten days. It cost about \$7.00 per month to operate the outfit and in warmer weather the egg increase just about paid the operating expenses. The straw saved just about paid for the kilowatt-hours used. Even though the tests were too brief to be conclusive, the results so far are promising.

CORN HUSKING AND SHREDDING

The electric motor furnishes a very reliable and steady power for operating the corn husker and shredder, no matter how cold the weather. The corn husker saves a lot of cold, disagreeable work during the late fall, and with the increase in the "borer" area, its use may become more general, since "shredding" is a very effective way of destroying the borer.

Energy Consumption and Power Requirements

In a more or less typical case it took 20 Kw. hrs. to husk 100 bushels of corn with a 2-roll husker, the fodder, of course, being shredded. With a 4-roll husker the consumption would undoubtedly be materially lower.

A 5 H. P. motor will very easily handle a 2-roll crusher, and with a little care in operating the power at optimum speed, just as in the case of the ensilage cutter, it should easily operate a 4-roll crusher. However, it is more difficult to elevate corn fodder than green ensilage corn, pound for pound, there being, of course, considerably less weight to handle in the case of the fodder. No data are available as to the energy required to shred and elevate fodder from which the ears have been removed.

CORN SHELLING

A 1 1/4 H. P. motor will easily operate the ordinary hand sheller and will save a lot of time and hard work, probably doubling the capacity as compared to hand operation. Often the belt can be placed directly on the flywheel, and in this case the speed of operation will usually be about right with an 1800 R. P. M. motor and the small size of pulley generally furnished with a 1 1/4 H. P. motor. The energy consumption is negligible--about .08 Kw. hrs. per bushel for

Energy Consumption

ent corn.

HAY HOISTING

Average Kilowatt-hours per ton of Hay Hoisted

Hoisting Height feet	Hoisting Height feet	Rop Speed Ft. per min.	H. P.	Energy	Rate
35	35	120	5	.65	Anniston
35	35	120	5	.10	New York
45	45		5	.48	Oregon
			3	.32	Alconstein
				.33	average

A motor driven hay hoist in many cases will enable the haying to be done with one less team than otherwise would be required. In addition there will be saved one boy's or man's time driving the team to do the hoisting. In New York they were also able to unload the hay in materially less time with a motor driven hoist than with a team. These latter tests were made by the Adirondack Power &

Light Corporation at Schenectady, New York.

Energy Consumption and H. P. Required

1. The energy consumption per ton of hay hoisted varies a great deal with the type of hoist and with the hoisting conditions, ranging all the way from .1 to .65 Kw. hrs., or an average of close to .4. It seems probable that the consumption should not run above .2 Kw. hrs. per ton hoisted with a properly designed hoist. At most, the consumption is low and probably will be less than 10 Kw. hrs. per season for the average farm.

Hoisting hay is an intermittent job and the maximum load may, without injury to the motor, run to practically 200% normal load. In most cases the rope speed is slower than when using horses, but the time lost is more than made up in returning the fork or slings. A 5 H. P. motor should be able to handle any job of hoisting with ease, 3 H. P. being ample in most cases. In fact, the Adirondack Power and Light Corporation found 2 H. P. sufficient with a drum rope speed of 120 ft. per minute. Due to the necessity of tearing the hay loose, when a fork is used, it does not take any more power to unload with a fork than with slings.

Conclusions

Most hay hoists need minor modifications in their design before they become entirely satisfactory.

The high first cost of hay hoists, especially since their use is so extremely seasonal, is undoubtedly an important factor in limiting the rapidity of increase in their use. This objection may be overcome, at least in part, by the use of the hoist for other purposes around the farm, such as hoisting sacks of feed, fertilizer, etc. In one case in Oregon a farmer used his hoist to remove part of the dirt in digging a well, it requiring a little over 1 Kw. hr. per cu. yd. of earth removed, the earth being hoisted an average of 18 feet.

1. The energy consumption per ton of hay hoisted varies a great deal with the type of hoist and with the hoisting conditions, ranging all the way from 1 to 85 Kw. hrs., or an average of close to 4. It seems probable that the consumption should not run above 2 Kw. hrs. per ton hoisted with a properly designed hoist. At most, the consumption is low and probably will be less than 10 Kw. hrs. per season for the average farm.

Hoisting hay is an intermittent job and the maximum load may, without injury to the motor, run to practically 200% normal load. In most cases the rope speed is slower than when using horses, but the time lost is more than made up in returning the fork or sling. A 5 H. P. motor should be able to handle any job of hoisting with ease, 5 H. P. being ample in most cases. In fact, the Edison Electric Power and Light Corporation found 2 H. P. sufficient with a drum rope speed of 120 ft. per minute. Due to the necessity of teasing the hay loose, when a fork is used, it does not take any more power to unload with a fork than with

sling.

Conclusions

Most hay hoists need minor modifications in their design before they be-

come entirely satisfactory.

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HAY BALING

An electric motor will furnish a very reliable and satisfactory motive power for stationary baling, almost all work being done with stationary presses. A 5 H. P. portable motor was used by the New York State College of Agriculture at Ithaca, New York, to bale hay in the fall of 1926. The work was very satisfactory but no operating data are yet available.

As much as 25 H. P. is required to operate hay presses, but most outfits require from 5 to 7-1/2 H. P. No reliable figures are available on the capacity and energy requirements but ordinary presses should turn out from 3 to 5 tons per H. P. per 10-hour day and should not require over .2 to .3 Kw. hr. per 120 lb. bale or, say, 3.5 to 5 Kw. hrs. per ton.

GRAIN AND SEED CLEANING AND GRADING

The carefully operated fanning mill is the farmer's greatest insurance against weed seeds and mixing of varieties, the latter often occurring in custom cleaning. Furthermore, the trash and undersized grain are removed at the same time. A motor will save the time of a boy or man turning and will result in more uniform work due to the constant speed. Furthermore, it makes the use of a sack-er practical which will shorten the total time by about one-half.

Energy Consumption and H. P. Required

One-half H. P. or less will operate most fanning mills, 1/4 H. P. in many cases. There is very little information available as to the energy consumption for small grains, but about 100 bushels can be cleaned and sacked with 1.7 Kw. hrs. It will take around 1 Kw. hr. to clean and grade 100 bushels of small grain or 20 to 30 bushels of small seeds. With similar screens the capacity is largely due to volume and therefore is only slightly affected by the weight of the material.

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 or, say, 3.5 to 5 Kw. hrs. per ton.

GRAIN AND SEED CLEANING AND GRADING

The carefully operated farming mill is the farmer's greatest insurance
 against weed seeds and mixing of varieties, the latter often occurring in custom
 cleaning. Furthermore, the trash and undressed grain are removed at the same
 time. A motor will save the time of a boy or man turning and will result in more
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Washington, and a fanning mill is almost a necessity to these growers.

GRAIN ELEVATING

Average Kw. hrs. per 1000 bushels elevated

State	C o r n		W h e a t			O a t s	B a r l e y	R y e
	Portable drag	Vertical cup	Tubular portable	Vertical cup	Fan	Fan	Fan	Fan
Illinois	10.1	5.7						
Iowa	9.6					9.9		13.3
Kansas			4.0	3.14	14.6			
Nebraska		4.5						
Oregon							33.0	
So. Dakota	2.5 *							
Wisconsin					13.3			
Average	9.9	5.1	4	3.14	13.9	9.9	33	13.3

* Approximately

The farmer, in the course of a year, usually has considerable corn, grain, and feed which must be handled. An elevator on these jobs saves a lot of work of the hardest kind. Furthermore, it enables using buildings of greater heights for storage--often a part of the barn right above the feeding alleys--and this, of course, represents a real saving in storage cost per bushel.

One of the chief deterrents to the more extensive use of elevators is their first cost. However, this cost is often more than offset by the cheaper storage which they make practical.

Corn

On the average it will take about 10 Kw. hrs. to elevate 1000 bushels with a portable drag elevator, and about half that with the vertical cup type. This variation is due to differences in design and construction of the two kinds, mostly the sliding friction between the slats and runway on the portable drag type. The average middle western farmer will probably use 20 Kw. hrs. per year for elevating.

Small Grains

With the vertical cup or tubular portable elevators it will take, on the average, from 3 to 4 Kw. hrs. to elevate 1000 bushels of wheat. The requirements

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average middle western farmer will probably use 20 Kw. hrs. per year for elevating the sliding friction between the slats and runway on the portable drag type. This variation is due to differences in design and construction of the two kinds, with a portable drag elevator, and about half that with the vertical cup type. On the average it will take about 10 Kw. hrs. to elevate 1000 bushels

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State	Corn		Wheat		Oats		Barley		Rye	
	Portable drag	Vertical cup	Tubular portable	Vertical cup	Portable	Vertical	Portable	Vertical	Portable	Vertical
Illinois	10.1	5.7	4.0	3.14	14.8	9.9	32.0	13.3	13.3	13.3
Wisconsin	8.6	4.5								
Nebraska										
Minnesota										
Dakota	8.5 *									
South Dakota	9.9	5.1	4	3.14	13.3	9.9	33	13.3	13.3	13.3

Average Kw. hrs. per 1000 bushels elevated

GRAIN ELEVATING

Washington, and a tanning mill is almost a necessity to these growers.

for elevating rye and barley will not be very different, probably a little less, but with oats they will be around 25% lower. These comparisons are made on a bushel basis. Where small grains are elevated by fans, the energy consumption will be at least three or four times as high, in exceptional cases climbing to eight or ten times, as for the regular elevator. The consumption, of course, will depend upon how well the machinery is adapted to elevating.

An elevator will save so much time that a farmer having very much grain to handle can scarcely afford to be without one. However, where most of his elevating will be small grains and he already has an ensilage cutter or similar machine the blower of which can be used for grain elevating, the purchase of an elevator would not be justified. The energy consumption in any case is not very important.

The farmer's reaction to the problem when he becomes acquainted with the facts is well illustrated by the remark of one Nebraska farmer when he found out how much it had cost him to put his corn in the crib: "That would hardly pay for the wear and tear on the scoop shovel."

ELEVATING SHAVINGS

A homemade blower with a 45 in. fan, 8-3/4 in. wide, was used to elevate wet and dry shavings 35 ft. into a mow, on an Oregon farm. These shavings were used for beddings. The blower was operated by a 10 H. P. motor at 960 R. P. M. The wet shavings could be elevated only about one-quarter as fast as the dry shavings, the rates being about 2 and 8 tons per hour respectively, and the power requirements less than 5 and close to 10 H. P. respectively. The power consumption was a little over 2 Kw. hrs. per ton elevated in the case of the wet shavings, and a little over 1 Kw. hr. per ton elevated in the case of the dry shavings. It is quite likely that a machine manufactured especially for this purpose would be considerably more efficient. However, it would seem probable that

for elevating rye and barley will not be very different, probably a little less, but with oats they will be around 28% lower. These comparisons are made on a bushel basis. Where small grains are elevated by fans, the energy consumption will be at least three or four times as high, in exceptional cases climbing to eight or ten times, as for the regular elevator. The consumption, of course, will depend upon how well the machinery is adapted to elevating.

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in a good many cases a farmer might use some machinery which he already had available. The Northern States Power Company are the only organizations which have interested themselves recently in various types of equipment.

FERTILIZER GRINDING AND MIXING

When fertilizer gets hard and lumpy from age the feed grinder may be used to pulverize it at very slight cost for energy by setting the burrs for very coarse grinding, as was done by one New Hampshire farmer. In that case the mill happened to be an old one, but there would seem to be no reason why the regular mill could not be used if it were properly cleaned afterwards by running through it some soil and then a little grain or feed. A hammer mill with the proper size of screen also should be satisfactory for this purpose. In many cases a portable motor will be used to operate the grinder.

When the fertilizer is properly pulverized the feed mixer or concrete mixer will save a lot of backbreaking work with the scoop shovel. In either case the portable motor might be used to operate the mixer.

GENERAL PURPOSE MOTOR

There are two types of factory made general purpose motors, the 1/4 H. P. mounted on a tripod, and the 3 to 7-1/2 H. P. mounted on wheels. Several years ago the 1/2 H. P. general purpose motor was manufactured and catalogued by a few manufacturing companies. Due to lack of demand its listing was discontinued. Interest now seems to be developing in this piece of equipment.

On the Indiana project a 1/4 H. P. portable motor with a 3-step pulley was used to operate a grindstone, washing machine, and water pump. The energy consumption was 3.5 Kw. hrs. per month. It gave splendid satisfaction. So far as is known, the director of the Indiana work is the only Project Director aggressively favoring this type of portable motor.

The larger size of general purpose motor--3 to 7-1/2 H. P.--has been used on several of the state projects, but, so far as is known, the Wisconsin Committee

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on the Relation of Electricity to Agriculture, the General Electric Company, and the Northern States Power Company are the only organizations which have interested themselves recently in working on improved designs for this type of equipment.

In Wisconsin, efforts have been directed toward the development of a direct drive type with speed variations obtained through an automobile gear shift. One of these has been built and used successfully. Another model is now being built in which changes indicated by experience will be incorporated.

The developments of the General Electric Company has passed through three stages and are still continuing. The first production was a 5 H. P. motor mounted on a 4-wheeled, electric welded truck, equipped with remote control, jack shaft and pulleys, and 50 ft. of connection cable. The wheels were too small and the price was too high.

The next step was a 2-wheeled, electric welded truck without jack shaft. The price was still too high.

When last seen, the motor and control were mounted on a 4-wheeled truck with a wooden platform. Costs were being reduced in an endeavor to build a general purpose 5 H. P. motor which can be sold for \$200.00.

The Northern States Power Company has developed an assembled general purpose motor. The construction details were not available for this report.

Field experience clearly indicates that it is not necessary to have a general purpose motor mounted on wheels. Many farmers use motors mounted on sleds or skids. It is difficult--in some cases impossible--for one man to move a 5 H. P. general purpose motor over rough or soft ground. When a horse, automobile, or tractor is used to move the motor, it is probable that skids are just as satisfactory as wheels.

There is a distinct difference of opinion regarding the future place of the general purpose motor in farm operations. In one case it is held that if a satisfactory 5 H. P. outfit can be sold for \$200.00 it will find a place of increasing usefulness. On the other hand, there is the conviction that there is no

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creasing usefulness. On the other hand, there is the conviction that there is no

place for the general purpose motor of either size. This school of thought contends that it will be the individual motor with an occasional shifting of motors from one job to another.

In between these two is the idea that the general purpose motor will be in demand during a transition from present conditions to the individual drive. Fortunately we may expect to have general purpose motors of both types on the market. Time will tell the extent of their adoption.

FARM SHOP

It is worth real money to the farmer to be able to repair or sharpen his farm equipment without making a trip to town. It will often save considerable in the form of wages for the hired man. Most farmers feel that the money invested in a farm shop is well spent. Due to the widespread need and desire for shop facilities, the manufacturer who can furnish reliable equipment of proper design at moderate prices is solving one of the farmer's real problems.

The energy consumption of the average small farm shop motor is very small, around .5 Kw. hrs. per month as an average for the year. However, a larger motor in a well equipped shop on a large farm will use 4 or 5 Kw. hrs. per month. In South Dakota a 3 H. P. Wagner motor in a shop equipped with a steel drill, wood lathe, grindstone, small circular saw, large meat grinder, two or three emery wheels and a buffer, all operated through a line shaft, used 52 Kw. hrs. in a year.

A 1 H. P. motor is amply large for most farm shops, but as the amount and size of the equipment increases, a 2 or 3 H. P. motor will be required. Individual drive would make the shop equipment still more expensive.

Equipment for the Shop

A farm shop should always contain a portable drill, a drill press (or its equivalent in the form of a stand for the portable), tool grinders, a buffer,

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a equivalent in the form of a stand for the portable), tool grinders, a buffer,

a combination rip and cutoff saw, an electric soldering iron, and often a wood lathe, a steel lathe, and other special equipment that happens to fit that particular farmer's needs.

PORTABLE AND STATIONARY TOOL GRINDING

An electrically driven tool grinder will considerably shorten the time required to sharpen the farm tools and will often save some one many tiresome hours turning the grindstone or cycle grinder.

A portable has some advantages over a stationary grinder as it can be taken out to the disc harrow, cultivator, or other farm machine requiring attention, which of course saves considerable time and energy. A small Rock Island grinder and a 1/4 H. P. motor mounted on a plain wooden base proved very satisfactory in some tests at the New York State College of Agriculture at Ithaca, New York, but when heavy grinding was done it was found necessary to use a little caution to prevent "stalling" the motor. This, of course, can be taken care of by having the belt loose enough so that it will slip when the motor is too heavily overloaded. This outfit operated most efficiently at 2700 R. P. M. A wheel dresser must be purchased as a part of such grinder as an unbalanced stone running at high speed is dangerous. An outfit quite similar to this one is being sold complete, without base, and ready to assemble, for \$25.00, by the Adirondack Power & Light Corporation at Schenectady, New York.

Energy Consumption

The energy consumption is very small, it taking, for instance, .04 Kw. hr., on the average, to grind an axe, .02 Kw. hr. to grind a 3/4" chisel, and .14 Kw. hr. to gum a 5 ft. crosscut saw. Saw gumming and the grinding of shear plates and mower knives is heavy grinding.

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I R R I G A T I O N

No attempt has been made to summarize the large amount of information available on the subject of irrigation. However, certain significant data made available from state projects which are working on irrigation, is presented.

From the standpoint of rural electric service the following are significant:

1. The practice of surface irrigation is spreading from arid to semi-arid farming regions.
2. Overhead irrigation has become a recognized practice with the growers of vegetables and small fruits in humid regions.

According to reports from California, for surface irrigation pumping, the efficiency of reciprocating pumps varies from 15% to 90%; centrifugal pumps from 20% to 80%; and turbine pumps from 20% to 85%. It is estimated that between 50% and 60% of the 40,000 pumping installations in this state have an efficiency of 50% or over.

For surface irrigation pumping it requires from 1.75 to 2 Kw. hrs. per acre-inch for each 10' of lift, with the efficiency ranging from 40% to 50%.

For most crops grown under California conditions the water requirements vary from 1 to 3 acre-feet per year, although with rice it may range from 5 to 6 acre-feet per year.

In Oregon especial attention has been given to results which can be obtained by the irrigation of vegetables and small fruits in the Willamette Valley. The average annual rainfall in this region is high, somewhere between 50 and 60 inches, but the summer months, June, July and August are generally dry.

C R O P

Extra net profit per acre from irrigation

Hops	\$94.12
Early Potatoes	35.10
Sweet Corn	58.50
Green Beans	108.00
Early Cabbage	208.40

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Two excellent bulletins have been published on Stationary Spray Plants: The Oregon work for the western part of the state is summarized as follows:

Bulletin 406, October, 1926, Stationary Spray Plants in California. By B. D. Mosser, W. V. Duran and T. A. Wood; published by University of California, Agricultural Experiment Station, Berkeley, California.

1. In Western Oregon two or three irrigations will produce the same crop as six or seven irrigations in more arid regions.

2. The electric motor is well adapted to irrigation pumping.

3. Hops can be irrigated in the average year with reasonable assurance of a good margin of profit.

4. It pays to irrigate early potatoes. The fall rains are usually sufficient to make a good crop of late potatoes.

5. Truck crops respond especially well to irrigation. The growing season is lengthened, the quality greatly improved, and the yield materially increased.

6. The same, with even more emphasis, can be said for small fruits as has been said for truck crops.

7. Fields should be carefully prepared for irrigation. The loss of time, labor and water in trying to irrigate an uneven field, or one with too little or too much slope, will soon exceed the cost of proper preparation.

For overhead irrigation the energy consumption will be higher for the same lift than is the case with surface irrigation as "friction head" must be overcome and pressure for spraying maintained.

The observations indicate that irrigation for vegetable crops and small fruits has the following advantages:

1. A longer growing season making possible 2 and 3 crops per year.

2. Preventing damage from frost under certain conditions.

3. Better quality of product.

4. Increased yield.

5. Water when it is wanted.

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 6. The same, with even more emphasis, can be said for small fruits as has been said for truck crops.
 7. Fields should be carefully prepared for irrigation. The loss of time, labor and water in trying to irrigate an uneven field, or one with too little or too much slope, will soon exceed the cost of proper preparation.
- For overhead irrigation the energy consumption will be higher for the same lift than in the case with surface irrigation as "friction head" must be overcome and pressure for spraying maintained.
- The observations indicate that irrigation for vegetable crops and small fruits has the following advantages:
1. A longer growing season making possible 2 and 3 crops per year.
 2. Preventing damage from frost under certain conditions.
 3. Better quality of product.
 4. Increased yield.
 5. Water when it is wanted.

STATIONARY SPRAY PLANTS

Two excellent bulletins have been published on Stationary Spray Plants:

Bulletin 406. October, 1926, Stationary Spray Plants in California. By B. D. Moses, W. P. Duruz and T. A. Wood; published by University of California, Agricultural Experiment Station, Berkeley, California.

General Bulletin 212. February 1927. The Stationary Spray Plant. By Harry L. Garver. Published by State College of Washington, Agricultural Experiment Station, Pullman, Washington.

The following summaries are made from data given in these bulletins:

INSTALLATION COSTS

State	COST PER ACRE		
	Minimum	Maximum	Average
California	\$29.00	\$106.00	\$51.35
Washington	65.00	126.00	90.40

It is difficult to explain the range of nearly 100% in these figures.

The California Bulletin says: "A fair average seems to be \$37.50 per acre."

The Washington Bulletin says: "In general, a plant complete, piping, hose and all, for an orchard of not more than 15 acres costs between \$1000.00 and \$1400.00." The Washington figures are based on 1926 prices.

It is worthy of note that in the Wenatchee district of Washington the total equipment costs per acre for stationary and portable spray outfits are about the same, on the average.

SIZE OF MOTOR CALIFORNIA DATA

Spray mixture	Lbs. per Sq. in.	H. P. per rod	H. P. per gun
Lime sulphur	325	.38	
" "	235	.39	
" "	240		2.00
" "	360	1.87	2.84
" "	300		1.58
Arsenate of lead	350	.91	
" " "	400	1.03	
" " "	415		3.12
" " "	415		2.40
" " "	380		.7

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The following summaries are made from data given in these bulletins:

INSTALLATION COSTS

State	COST PER ACRE		
	Minimum	Maximum	Average
California	\$22.00	\$108.00	\$51.35
Washington	22.00	126.00	80.40

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total equipment costs per acre for stationary and portable spray outfits are

about the same, on the average.

SIZE OF MOTOR
CALIFORNIA DATA

H. P. per min	H. P. per rod	lbs. per sq. in.	spray mixture	
			lime sulphur	arsenate of lead
	.38	325	"	"
	.38	335	"	"
2.00		340	"	"
2.84		360	"	"
1.58		300	"	"
	.91	360	"	"
	1.03	400	"	"
3.12		415	"	"
2.40		415	"	"
7.		380	"	"

WASHINGTON DATA

Capacity of Pump Gal. per minute	H. P. of Motor
0 - 14	5
12 - 25	7.5
20 - 30	10
25 - 40	15

WASHINGTON DATA

Size of Motor	Number of Plants	Total Acres	H. P. per Acre
1.5 H. P.	1	4	.375
2 H. P.	3	14	.428
3 H. P.	19	184	.310
5 H. P.	58	708	.409
7.5 H. P.	14	299	.352
10 H. P.	2	70	.286
Average			.376

The size of outfit will depend primarily upon the rate of spraying. It varies from 2 to 3.5 acres per H. P. on small farms up to 40 acres. In large orchards, (around 250 acres), this figure has run as high as 25 acres per H. P.

From the table below it would seem that the size of plant could easily be estimated if the permissible length of time for one spray were known approximately. From 1/3 to almost 1/2 acre per hour can be sprayed per gun or rod, (depending upon conditions), with a spray consumption of from 90 to around 200 gallons per hour per nozzle, 3.5 to nearly 7 gallons per tree.

RATE OF SPRAYING (California Data)

Test group	A	B	C	D	E	F
Total gals. of spray	71,756		23,200	17,400	13,200	
Acres Sprayed.....	260		55	42	31	30
Number of nozzles in operation*	13r		5g	3g	2g	6g
Total number of men employed.....	30		8	6	3	8
Total number of trees	20,200		3,500	4,524	3,320	2,250
Trees to the acre....	77.7		63.6	107.7	107.2	75
Hours to spray.....	61.5		33	33	47	10.8
Acres sprayed per hour	4.23		1.67	1,274	66	2.78
Trees sprayed per hour	328.5		106.2	137.2	70.6	208.2
Gals. per nozzle per hr.	89.7		140.6	176.0	140.5	
Acres sprayed per nozzle per hr.....	.325		.333	.425	.3295	.463
Trees sprayed per nozzle per hr.	25.3		21.22	45.7	35.3	34.7
Gallons per tree	3.55		6.62	3.85	3.98	

* r represents rods; g represents guns.

WASHINGTON DATA	
Gals. per minute	H. P. of Motor
0 - 14	2
15 - 25	7.5
26 - 30	10
31 - 40	15

WASHINGTON DATA			
Size of Motor	Number of Plants	Total Acres	H. P. per Acre
1.5 H. P.	1	4	.375
2 H. P.	3	14	.428
3 H. P.	19	184	.310
5 H. P.	58	708	.409
7.5 H. P.	14	298	.355
10 H. P.	2	70	.388
Average			.378

The size of outfit will depend primarily upon the rate of spraying. It rises from 2 to 3.5 acres per H. P. on small farms up to 40 acres. In large orchards, (around 250 acres), this figure has run as high as 25 acres per H. P. From the table below it would seem that the size of plant could easily be estimated if the permissible length of time for one spray were known approximately. From 1/3 to almost 1/2 acre per hour can be sprayed per gun or rod, depending upon conditions, with a spray consumption of from 90 to around 300 gallons per hour per nozzle, 3:5 to nearly 7 gallons per tree.

RATE OF SPRAYING (California Data)					
Test Group	A	B	C	D	E
Total gals. of spray	71,758	23,200	17,400	13,200	30
Acres sprayed.....	280	55	42	31	68
Number of nozzles in operation.....	137	55	35	25	8
Total number of men employed.....	30	8	6	3	2,380
Total number of trees to the acre....	20,200	3,500	4,524	3,320	75
Acres to spray.....	77.7	63.6	107.7	107.2	10.8
Acres sprayed per hour	4.23	1.67	1.274	.66	2.78
Gals. sprayed per hr.	328.5	106.2	137.2	70.8	208.2
Gals. per nozzle per hr.	89.7	140.8	176.0	140.5	
Acres sprayed per nozzle per hr.....	.325	.332	.425	.3295	.462
Acres sprayed per hr.	25.3	21.22	45.7	25.3	34.7
Gallons per tree	3.65	6.62	3.85	3.98	

* 7 represents rods; 8 represents guns.

Current Consumption

On the basis of data in the Washington Bulletin it requires approximately 6.75 Kw. hrs. per spray per acre, or close to 50 Kw. hrs. per acre per year.

Mains and Laterals

Two pipe systems are in use, the "return" and "dead end". The mains are from 1" to 1½" in size and are usually located through the center or at the side of the orchards. The laterals are from ¾" to 1" in size and spaced from 120 to 192 feet apart. As a rule, only one gun should be used on a ¾" lateral.

Use of Stationary Spray Plants

At the present time the general use of the stationary spray plants by orchardists is confined almost entirely to the Wenatchee District of the State of Washington. A. R. Chase, County Agricultural Agent, Wenatchee, Washington, estimates that half of the 2500 orchardists in the county are using stationary spray plants.

FRUIT GRADING

Apples

The apple grader is a commercial success and is standard equipment where any sizable quantity of apples is being handled for the better class of markets.

The greatest limiting factor to the more general use of apple graders is the high first cost. For instance, a small grader with a capacity of around 25 boxes per hour with an experienced crew of 4 or 5 packers, 2 graders and receivers and one nailer will cost around \$800.00. It would seem that a grower, to justify such a machine, should have an average crop of from 4,000 to 6,000 bushels, or enough to keep the machine busy about a month. Under other circumstances apple grading should become a community enterprise.

Energy Consumption and H. P. required

The energy consumption is relatively small, ranging from .5 to 1.5 Kw. hr., or an average of about 1 Kw. hr. per 100 bu. or boxes graded, a box being

On the basis of data in the Washington Bulletin it requires approximately

75 Kw. hrs. per spray per acre, or close to 50 Kw. hrs. per acre per year.

Lines and Laterals

Two pipe systems are in use, the "return" and "dead end". The mains are from 1" to 1½" in size and are usually located through the center or at the side of the orchards. The laterals are from ¾" to 1" in size and spaced from 120 to 200 feet apart. As a rule, only one gun should be used on a ¾" lateral.

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FRUIT GRADING

The apple grader is a commercial success and is standard equipment where a sizable quantity of apples is being handled for the better class of markets. The greatest limiting factor to the more general use of apple graders is the high first cost. For instance, a small grader with a capacity of around 25 boxes per hour with an experienced crew of 4 or 5 packers, 2 graders and receivers and one trailer will cost around \$800.00. It would seem that a grower, to justify such a machine, should have an average crop of from 4,000 to 6,000 bushels, or enough to keep the machine busy about a month. Under other circumstances apple grading should become a community enterprise.

Energy Consumption and H. P. required

The energy consumption is relatively small, ranging from .8 to 1.5 Kw. or an average of about 1 Kw. hr. per 100 bu. of boxes graded, a box being

almost a bushel. With the proper size of motor and a little care in running, it would probably not take over .5 Kw. hr. per 100 boxes.

Most graders are operated by $\frac{1}{2}$ H. P. motors, although $\frac{1}{3}$ H. P. in many cases is sufficient. In one case in Indiana the energy consumption per 100 bu. was increased by over 300% thru the use of a $1\frac{1}{2}$ H. P. motor as compared to a $\frac{1}{2}$ H. P.

Other Fruits

The above discussion should apply almost without modification, insofar as the relative importance of first cost and energy consumption is concerned, to other fruits such as prunes and peaches for dehydration or boxing, but no definite information is available.

ELECTRIC LIGHTS FOR PEST CONTROL

The use of electric lights on 12 acres of the 32-acre truck farm of L. W. Purdum and Sons at Denville, Virginia, has resulted in a yearly saving in the tomato crop, which it protects from tomato worms, of between \$2,000.00 and \$4,000.00 per year. The first year after the lights were installed the losses were reduced about 50%, and since then the losses have been very small. No tomato worm moths were caught, the results apparently being due to the capture of some insect which preyed on the enemies of the tomato worm in one of its four stages.

The lights were installed at the rate of about 3 per acre, at a cost of \$26.00 each, or \$900.00 for the total installation. The lights are of 150 watt capacity, are protected from irrigation water and rain by reflectors, and have a 3 quart pan containing kerosene hung to the reflector about 6 inches under each lamp. The 35 lamps used are lighted for about 10 hours per night, and at 10¢ per Kw. hr. it costs about \$5.25 per night to operate them. They are never turned on except during hot sultry nights when it has been found they are most effective.

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The results in Virginia have been so striking and the extension of the

same principle to other crops so promising that widespread interest has been aroused in the whole problem. New York is working on quite an extensive program in which various interested educational and commercial groups and organizations are making a cooperative study of the entire subject with reference to wave lengths, light intensities, etc.

Some very interesting work has been done in Japan on the control of rice insects by electric lights. Through the use of one 50 watt lamp for each 2.5 acres, the crop damage was reduced by an average of about 5% (estimated). Apparently it cost five or six times as much to get the same protection with kerosene lamps, everything considered. The lamps were hung about 3 ft. above the water and the moths would fly into the oil-coated water in the pans below the lights and drown, apparently being attracted by the reflected light. With low light intensities a much smaller percentage of females than males were attracted, while with the 50 watt lamps a much larger percentage were females than males. The useful insect population did not seem to be affected, probably due to their day-flying habits. The lights were on about 40 nights per season. Some tests with electric lights for protecting tea and mulberry trees, in 1926, were also very gratifying.

REMOVING POISON SPRAY FROM APPLES

At the State College of Washington, at Pullman, a study is being made of different possible methods of removing excessive amounts of arsenic from the surface of apples. It appears that the mere wiping of the visible portion removes a very small part of the poison and, since excessive washing destroys the keeping qualities, other methods, such as washing in weak acids, are being tried. Electric wiping for the purpose of removing moisture may also be tried. A 5 H. P. motor is being used to operate the washer although this motor is considerably larger than necessary.

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FRUIT REFRIGERATION

There is a big field for the refrigeration of soft fruits in the Middle West and South. At present some growers are using ice but obviously refrigeration would be a great improvement and should be cheaper where any considerable quantity of fruit is handled. No definite figures are yet available as to the cost of operating, temperatures desired, etc., but investigational work is planned for the near future in Indiana and New York. However, electric fans are used on the Purdue farm at Bedford to keep the air moving over ice so that a maximum amount of refrigeration is obtained in a given length of time.

A well constructed and insulated cellar in the latitude of central New York will successfully carry apples of good quality through the ordinary storage season. However, adequate pre-cooling might extend the keeping period in some cases. Along this line it is worthy of note that a fruit farmer near Burnt Hills, New York, is cooperating with the Adirondack Power and Light Corporation in an attempt to find out what practical contribution electricity can make to the solution of his storage problems. A 24 in. fan was installed so that on cold nights the outside air can be driven in among the barrels of fruit, mainly apples. Two small General Electric refrigeration units with a combined capacity of around 2,000 B. Th. U. per hr. were also installed so as to maintain the temperatures obtained during the heat of the day. This is all they can be expected to do as the cellar is uninsulated and contains about 10,000 cu. ft. of storage space. The units are so installed that during the day when they are in operation the air driven over their cooling coils by a 12" desk fan on "low" flows through a canvas duct on the floor and gradually rises, the lighter warm air floating on top and acting as an insulating blanket for the plank floor above.

Operating figures are not yet available to indicate how effective the units are, but, according to the farmer, they did enable him to carry a large quantity of pears over the week end, for a better price, than otherwise he would

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Operating figures are not yet available to indicate how effective the units are, but, according to the farmer, they did enable him to carry a large quantity of pears over the week end, for a better price, than otherwise he would

have had to dump on the market immediately. Operating data undoubtedly will be obtained in 1927.

One of the chief deterrents to the wider use of refrigeration for fruit is the high first cost as compared to the extremely seasonal use under average conditions. However, it is quite possible that a little different method of handling and marketing fruit might solve the problem for many farmers. A farmer with a refrigeration plant might make arrangements for pre-cooling or even temporarily storing the soft fruits of his neighbors as well as his own. Such an arrangement would sometimes save berry, peach, pear, and other growers a considerable loss.

HAY DRYING

A. ENGLISH STACK METHOD - HAY AND SHEAF GRAIN

(a) Hay Drying Costs from the Institute of Agricultural Engineering, University of Oxford

(The costs have been changed to dollars and cents)
(and the tons from long to short.)

Comparison of Average Costs per ton of Material

1. In a good season

	<u>Artificial Method</u>	<u>Ordinary Method</u>
Cutting	\$.65	\$.65
Carting and Stacking	1.52	1.30
Making		.98
Artificial Drying	.33	
Total	<u>\$ 2.50</u>	<u>\$ 2.93</u>

2. In a bad season

	<u>Artificial Method</u>	<u>Ordinary Method</u>
Cutting	\$.65	\$.65
Carting and Stacking	1.52	1.30
Making		1.95
Artificial Drying	.33	
Total	<u>\$ 2.50</u>	<u>\$ 3.90</u>

The ordinary method is 17% more expensive (per ton) in favorable seasons and 56% more expensive in unfavorable seasons.

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Comparison of Average Costs per Ton of Material

		<u>In a good season</u>	
	<u>Artificial Method</u>		<u>Ordinary Method</u>
Cutting	\$.68		\$.68
Carting and Stacking	1.52		1.30
Making			.98
Artificial Drying	.38		
Total	<u>\$ 2.50</u>		<u>\$ 2.96</u>
		<u>In a bad season</u>	
	<u>Artificial Method</u>		<u>Ordinary Method</u>
Cutting	\$.68		\$.68
Carting and Stacking	1.52		1.30
Making			1.92
Artificial Drying	.38		
Total	<u>\$ 2.50</u>		<u>\$ 3.90</u>

The ordinary method is 17% more expensive (per ton) in favorable seasons
and 56% more expensive in unfavorable seasons.

(b) Chemical Analysis of Meadow Hay from the University of Oxford, 1924

	Water	Albuminoids	Fats	Carbo- hydrates	Fibre	Ash	Nitrogen
Dried by crop-drying system	14.0	12.5	2.9	43.2	20.9	6.5	2.1
Weathered Hay	20.0	9.0	2.2	32.0	30.2	6.5	1.5
Fermented Hay	20.3	10.6	1.7	32.2	28.7	6.5	1.7
Good Hay made by Ordinary Methods	15.0	11.7	2.8	41.6	21.9	7.0	1.9

(c) In a typical case where the stock contained about 7.28 tons of dried hay at the end of the test, the following are the tractor and fuel costs alone, (the tractor operating the fan), and the table of analyses before and after drying:

Running Costs

Fuel Oil	75.6 gals. @	7.52¢	\$5.68
Tractor	7.5 hrs. @	24-1/3¢	1.82
			<u>\$7.50</u>

Cost per ton of dried hay \$1.04

Analyses

Grass sample taken right after cutting

Dried Grass sample taken after blowing

	Per cent	Calculated to dry basis	Per cent	Calculated to dry basis
Moisture	77.07		17.86	
Oil	0.85	3.70	3.01	3.66
Protein	2.53	11.04	8.45	10.29
Carbohydrates	11.12	48.49	42.14	51.31
Crude Fibre	7.01	30.58	23.45	28.55
Ash	1.42	6.19	5.09	6.19
	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>

The English stack method of drying with hot air has proven very profitable and practical under English farming conditions. At the bottom of the stack a conical shaped hole of proper dimensions, depending on the size of stack, insures a uniform air flow through a properly built stack.

In a typical case where the hay had dried for about 24 hours and then had been soaked by a good rain before and while it was being stacked, it took 7.5

Chemical Analysis of Meadow Hay from the University of Oxford, 1924

ed by crop- ing system	Water	Aluminoids	Fats	Carbo- hydrates	Fibre	Ash	Nitrogen
	14.0	12.8	2.9	43.2	20.9	6.8	2.1
ched Hay	20.0	9.0	2.2	32.0	30.2	6.8	1.2
mented Hay	20.3	10.6	1.7	32.2	28.7	6.8	1.7
Hay made by inary Methods	18.0	11.7	2.8	41.6	21.9	7.0	1.9

In a typical case where the stock contained about 7.28 tons of dried hay at end of the test, the following are the tractor and fuel costs alone, (the tractor operating the fan), and the table of analyses before and after drying:

Costs	Tractor	Fuel Oil
	7.8 hrs. @ 24-1/2	75.8 gals. @ 7.52
	1.82	\$5.88
	<u>\$1.80</u>	
Cost per ton of dried hay	\$1.04	

Calculated to dry basis	Per cent	Calculated to dry basis	Per cent	Calculated to dry basis	Per cent
17.85	17.85	17.85	17.85	17.85	17.85
3.01	3.01	3.01	3.01	3.01	3.01
8.45	8.45	8.45	8.45	8.45	8.45
42.14	42.14	42.14	42.14	42.14	42.14
23.45	23.45	23.45	23.45	23.45	23.45
5.09	5.09	5.09	5.09	5.09	5.09
<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>

The English stack method of drying with hot air has proven very profitable and practical under English farming conditions. At the bottom of the stack a hole of proper dimensions, depending on the size of stack, insures form air flow through a properly built stack.

In a typical case where the hay had dried for about 24 hours and then had soaked by a good rain before and while it was being stacked, it took 7.5

hours to dry a stack of about 7.3 tons or about 1 hour per ton dried with an air flow of 12,000 cu. ft. per minute or 720,000 cu. ft. per ton dried, the air being at an average duct temperature of 185°F. and maximum of 195°F. It took about 10 gallons of fuel oil per hour with a calorific value of about 19,000 B. Th. U. per lb. (probably 135,000 B. Th. U. per gallon). This makes about 10 gallons of fuel oil per ton dried, and is typical of what may be expected. Where the hay has dried for about 24 hours it generally loses about one-third of its moisture, and if rain then falls on it, the drying time is apparently not greatly affected. Where the hay is fresh it will take about 12 hours to dry a stack under similar conditions which formerly took 8 hours.

Grain drying is more difficult, but due to the smaller amount of moisture it does not seem to take any longer to dry a stack of similar size.

B. URQUHART DRIER - HAY

The Buhl Stamping Co. of Detroit, is in a position to manufacture a hay drier with a capacity of 1 ton per hour, for \$2,500. This drier was designed by Mr. Norman Urquhart.

The drier is steam heated and the hay is pushed forward through two parallel tubes at the top and then back through two more tubes at the bottom. One feature of especial merit, according to the designer, is the exhausting of the air above the hay in the two top tubes by fans. The temperature of the hay tubes does not rise above 320°F. The plant will be on wheels, and portable, weighing not over 7,000 lbs.

Estimated Cost of Operation based on a 10 hour day

Six men and three teams	\$25.00 per day
Cutting box and tractor, including depreciation	7.50 " "
Dehydrator, including depreciation	7.50 " "
Fuel on the basis of 1 lb. (12,000 B. Th. U.) per 9 lbs. water	17.50 " "
	\$57.50 per day

This would make about \$5.75 per ton on a basis of 1 ton per hour, and

ure to dry a stack of about 7.5 tons or about 1 hour per ton dried with an air flow of 12,000 cu. ft. per minute or 720,000 cu. ft. per ton dried, the air being an average duct temperature of 135°F. and maximum of 150°F. It took about 10 gallons of fuel oil per hour with a calorific value of about 19,000 B. Th. U. per gallon. (probably 135,000 B. Th. U. per gallon). This makes about 10 gallons of fuel oil per ton dried, and is typical of what may be expected. Where the hay has been dried for about 24 hours it generally loses about one-third of its moisture, and rain then falls on it, the drying time is apparently not greatly affected. ere the hay is fresh it will take about 12 hours to dry a stack under similar conditions which formerly took 8 hours. Grain drying is more difficult, but due to the smaller amount of moisture it does not seem to take any longer to dry a stack of similar size.

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Estimated Cost of Operation based on a 10 hour day

12,000 B. Th. U. per 9 lbs. water	
Fuel on the basis of 1 lb.	
Dehydrator, including depreciation	7.50
Grinding depreciation	7.50
Cutting box and tractor, including depreciation	7.50
Six men and three teams	\$25.00 per day
	\$37.50

This would make about \$5.75 per ton on a basis of 1 ton per hour, and

does not include overhead, etc. on a steam plant.

C. MASON SYSTEM - HAY

In this system the hay is first cut by field machines which elevate it into wagons or trucks after chopping it into about 8" or 10" lengths. It is then carried to the drier where it is woven into a mat and carried on a long apron, the entire plant being about 160 ft. long, while hot flue gases are driven through it so that it is dry by the time it leaves the apron and is chopped up and delivered to the sacker or storage barn. The plant has a connected load of about 90 Kw. and is claimed by Mr. Mason to use around 1000 lbs. of coal per ton of hay dried. So far the plant at Plainsboro, New Jersey, has required considerably more coal per ton and has not produced the expected 2 tons of dried hay per hour.

The Mason drier has the disadvantage of high first cost, the plant at Plainsboro actually costing around \$30,000. with the field machinery, and there is considerable fire hazard. The plant at Plainsboro burned out and had to be generally overhauled last summer. It is also rather complicated mechanically and probably will be hard to keep in repair. It will take about 35 or 40 Kw. hrs. and at least 1000 lbs. of coal per ton of hay dried with this drier.

D. HERO SYSTEM - HAY

The Hero System consists of a huge rotating cylinder with the hay carried along by a blast of air as it becomes dry enough to be picked up, although the rotating cylinder keeps it slowly moving towards the dry end. The plant is so designed that there is very little heat loss, the furnace walls being double, and the flue gases traveling through a central chamber and then back through an outside chamber around the hay before entering the exhaust flue. The hay goes to the far end of the cylinder and then back.

This plant, it is claimed, has a capacity of about 3 tons of dried hay

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per hour and requires a total of from 80 to 100 gallons of fuel oil per 10-hour day to operate the Diesel engine driving the cutter and other machinery and to feed the furnace.

This plant is not portable but does not take up a great deal of room. While there are no figures on which to base reliable estimates as to its efficiency, it must be several times as efficient as a system like the "Mason". It probably would cost around \$30,000. complete without field machinery.

E. ADT DRIER - HAY

A drier manufactured by the Adt Manufacturing Co. of Baltimore, Maryland, and selling, complete, for around \$8,000. would seem to have some promise. It has in the past been largely used for tobacco drying and would dry about 1 ton of hay per hour. It is a machine of known qualities and is steam heated.

CONCLUSIONS

In many sections, such as the South, there is real need for a hay drier, as the harvesting of the hay crop is extremely difficult and the losses often heavy. Even in other sections generally more fortunate, a practical hay drier would often save vast sums for the growers.

In the South, where the hay must generally be placed in small ricks to cure, the English stack system may prove practical, but in other sections some system like the "Hero", together with proper field machinery--probably somewhat like that used with the Mason drier--would seem more promising, due to the labor saved.

One of the big claims made for the hay drier is the better hay it makes. Mr. Mason also claims that the hay drier makes possible a much more sensible agriculture based on grasses and other uncultivated crops that can be used for hay.

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DEHYDRATION OF FRUITS

1. PRUNES

(The greater part of the material given below comes from California Bulletin #404; the remainder from Oregon)

Drying Ratios for Common Fruits

Apples	8 : 1
Apricots	4-7 : 1
Figs	1-1/2 : 1
Peaches	4-7 : 1
Pears	4-7 : 1
Prunes	2-2 1/2 : 1

Growth of Prune Dehydration in California (Calif. Bul. #404)

Year	Number of Dehydrators used on prunes	Dry Tons Dehydrated	Total Dried*	Proportion Dehydrated
1921	48	2,946	100,000	2.9%
1922	126	13,356	132,000	10.1%
1923	178	16,810	131,000	12.8%
1924	244**	23,780**	139,000	17.1%
1925	310**	30,750	145,000	21.2%

* Compiled by Dried Fruit Association of California

** Estimated

Comparative Costs of Sun-Drying and Dehydrating Prunes by both Natural and Forced Draft Methods (per fresh ton) (Calif. Bul. #404)

Averages	Dehydrating		Sun Drying
	Forced Draft	Natural Draft	
Labor			
Dipping and traying	\$.75		\$.78
Operating dehydrator	.73		
Scraping trays	.89		3.11
Total labor	\$2.37	\$3.90	\$3.89
Fuel			
Dipping and drying	.95	3.26	.16
Power			
Dipping and drying	.69	.06	.05
Lye			
Dipping	.11	.08	.11
Total Operating Cost	\$4.12	\$7.30	\$4.21

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Shipping and drying	\$.75	\$.78
Operating dehydrator	.73	
Operating trays	.89	2.11
Total labor	\$2.37	\$3.89
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Shipping and drying	.96	3.26
Power		
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Shipping	.11	.11
Total Operating Cost	\$4.12	\$7.30
		\$4.21

From the second table above it is evident that the use of dehydration in California is increasing very rapidly, having increased from 2.9% in 1921 to 21.2% in 1925. Considerable work has been done in Oregon on prune drying and a bulletin will be published on the subject. Due to Oregon's climatic conditions no sun drying is done, but it was found in a recent survey that in 1925 approximately 1000 H. P. was installed in prune driers for operating the fans in forced draft dehydrators.

Dehydration produces prunes of equal or better quality than the sun dried, generally results in a greater yield and size of prunes, provides insurance against rain damage losses, and the total cost of operating an efficient dehydrator, including fixed charges, need be no greater than for a dry yard of equal capacity.

The average fixed charges for 6 modern air blast dehydrators was \$3.65, and for the average air drier \$3.43, these plus operating costs giving totals of \$7.76 and \$7.64 per fresh ton of prunes or close to 1¢ per lb. of dried fruit. It generally takes about 1 acre of tray space for each 20 acres of fruit, where sun drying is practiced, and only 5% of this with forced draft dehydrators.

Energy Consumption

At present, electricity is not used for heating purposes in prune drying and, due to the large amount of moisture which must be driven off, probably never will be used in this way except to the extent necessary to secure close heat regulation.

The energy consumption for fan operation per fresh ton of prunes averaged around 32.2 Kw. hrs. or say 80 Kw. hrs. per ton of dried prunes in California, or around 95 Kw. hrs. per ton in Oregon, the prunes being larger and more difficult to dry in the latter state.

The season lasts only about 3 weeks.

H. P. Requirements. Drier Capacities, etc.

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In Oregon the dehydrators require an average of around 1.87 H. P. per ton of capacity in fresh fruit, 15 H. P. being the average size of motor on present installation although 20 to 25 H. P. is being used on most of the new installations since they are of larger capacity. The driers have capacities ranging from 30 to 800 tons of fresh fruit, or an average of around 300 tons, during the 3 weeks season.

The 12.5% larger H. P. requirement in Oregon, as compared to California, is due to the larger average size of prunes, a square foot of fresh trayed Oregon prunes, (1 layer deep), weighing 4-1/2 lbs. as compared to 3-1/2 in California.

Dehydrator Considerations

(a) The installation of a fan in a natural draft drier increases the capacity about 50%. In Oregon the new orchards coming into bearing during the next few years will require an increase in dehydrator capacity of about 60%. This will undoubtedly be mostly taken care of through the installation of electric fans in natural draft dehydrators, thus saving the cost of additional driers in the majority of cases.

(b) There are three main systems of air heating used in California prune dehydrators:

1. Direct heat
2. Direct Radiation
3. Indirect Radiation

For each 27°F. raise in temperature the carrying capacity of the air is doubled. Usually the prune drying is started at 120° to 140°F., 160° being the critical temperature, and finished at 165°, as higher temperatures at the start cause case hardening and lower temperatures increase power and operating costs

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After drying is started the temperature of the prunes is of course lower than the temperature of the air thermometer would indicate, approaching that of the wet bulb.

(c) The humidity in the dehydrator should be kept at around 25% as a higher figure will lower the quality of the prunes and greatly increase the time and cost of drying. Lower humidities will cause case hardening.

(d) Drying times in dehydrators range from 20 to 36 hrs., running from 28 hrs. up for large prunes, 40 or less per lb., and around 24 hours for 50 to 60 per lb. sizes. This assumes a drying ratio of 2.5 : 1.

(e) Dehydrators are of the natural draft or air blast type. The latter type are of the recirculating type and the air is:

1. Drawn direct from drying chamber and recirculated by blowing it through the heating chamber.

2. Blown thru the drying chamber and drawn thru the heating chamber. A static pressure of from 1 to 2" of water is generally maintained. The air velocity is at least 500' per minute, generally around 600 to 700. The aggregate area of air passages between the ends of the trays should be around 60% of the total cross sectional area of the drying chamber.

The fans used are of two main types:

1. Disc and propeller with 8 to 14 blades.
2. Centrifugal or multivane fans with 48 or more short blades.

(f) Most California growers find it just as cheap to buy a manufactured dehydrator as to build, or design and build, one themselves.

Conclusions (mostly from Oregon)

1. A \$6,000. to \$10,000. prune drier will often do the same work as the \$20,000. drier. Patents and elaborate features of design often increase the cost without improving the drying efficiency or the quality of the product.

2. Forced draft will increase the capacity of a natural draft drier

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4. None of the growers who have once tried a drier with forced draft ventilation would go back to the older type.

5. A forced draft drier is obviously independent of the weather and will often prevent a considerable loss among the growers.

6. The prune drying load has proven a big incentive to line extensions, the general load following.

2. OTHER FRUITS

The drying problems with other kinds of fruits will be quite similar to those with prunes, but in most cases more severe, due to the higher moisture content.

DEHYDRATION

H O P S

In Oregon about 3% of the hop driers are using forced draft for drying, according to a survey made in 1926. As a general thing, the hop driers are of the same design as those which have been used for generations and would seem to merit some improvements in design.

The kilns are generally 30' square, one room, with the drying floor 14 to 20' above the ground. The hops are placed on the lattice floor 14 to 18" deep.

Energy Consumption

In a particular case a 15 H. P. motor was used to drive the ventilating fan and a total of 50,000 lbs. of hops were dried by this machine in a 20 day season. It therefore seems probable that a hop drier will consume from 125 to 150 Kw. hrs. per 1000 lbs. of hops dried, or say 5 to 10,000 Kw. hrs. per season per drier on the average, from the Power Company's standpoint. In making estimates an approximation may be obtained by assuming 5 bales or 1000 lbs. of hops per acre as an average production.

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Time that can be saved thru the use of forced draft drying

For a basis of comparison it may be assumed that, on the average, it will take 16 hrs. to dry a kiln of hops by natural draft methods and only 9 hrs. with forced draft, enabling the grower to get along with 45% less drier space than he would otherwise require.

As mentioned under walnut drying, the hop, prune and walnut loads when developed as a group should prove quite attractive to the power companies as there is very little overlapping of seasons.

GRAIN AND SMALL SEED DRYING

With the advent of the combine a new problem in the harvesting of small grains and seeds has become prominent. It is not likely that there will often be any need for drying the common grains, but small seeds such as sweet clover almost always need some drying due to uneven ripening which results in a portion of the seed being green. The common practice is to spread the seed several inches deep on the barn floor and then to turn it at regular intervals with a scoop shovel. Inadequate turning will result in heating and low germination. It is common knowledge that blue grass seed is notorious for being low in germination, generally due to heating in the seed piles.

In some drying tests with sweet clover seed at the University of Illinois an elevator was used to carry the seed from the foot of the drying shaft to the storage bin. The seed flowed from the storage bin over baffles in the drying shaft while hot air was being drawn from over an enclosed oil heated brooder stove and driven through the grain. The drying was quite successful.

In Kansas a large fanning mill has been installed in connection with a farm granary so that the grain can be subjected to the fanning mill's blast on its way to another bin. In this way, it is thought the grain will be cooled by the fanning mill and by moving it from bin to bin, heating will be prevented. One bin will of course need to be empty. The cost of operation would be

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negligible as the outfit has a capacity of 250 to 300 bu. per hr. and can be operated with less than a 1.H. P. motor, i. e., both elevator and fanning mill. At most it will not take over 2 or 3 Kw. hrs. per 1000 bu. moved.

Summary Cost Table Giving the Maximum, Minimum, and Average Values for Various Methods of Heating Walnut Dryers of the Recirculation Type

CORN DRYING

There are two classes of corn drying which should be considered. In one case the grower merely wants the corn to keep until it is fed and in the other case he really wants to dry it.

(a) Considerable work has been done on drying corn in the Crib at the University of Illinois. In the most successful tests .93 gal. of fuel oil and .66 Kw. hrs. were used per bu. of corn dried in a crib holding around 200 bu. In the different tests the amount of moisture removed ranged from 20 to 37%. The air was heated to 125°F. It is probable that corn could be dried with unheated air early in the season. However, most middle west corn which is harvested is cribbed rather late.

(b) In Minnesota one farmer was able to dry 400 bu. of corn by operating an 18" 144 watt fan, with an actual air capacity of 1500 cu. ft. per minute, 1½ hrs. daily for 2 weeks. It took about 3 Kw. hrs. to dry the corn. Of course, the main object of this drying was to prevent spoilage until the corn was fed up in the late spring.

One of the main reasons for this farmer's success, was probably the type of installation which placed the air where it was wanted. A long distributing pipe with laterals under the crib floor at intervals of 3 or 4 ft. was used, the corn being about 5' deep. The laterals had 16" screened air vents at 2' intervals thruout their length. The long distributing pipe connected up with the 18" exhaust fan was used to ventilate the cow stable, the fan doing double duty when the corn was being dried.

negligible as the outfit has a capacity of 250 to 300 bu. per hr. and can be operated with less than a 1 H. P. motor, i. e., both elevator and fanning mill. It most it will not take over 2 or 3 Kw. hrs. per 1000 bu. moved.

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WALNUT DEHYDRATION

Summary Cost Table Giving the Maximum, Minimum, and Average Value for
Various Methods of Heating Walnut Dehydrators of the Recirculation Type
in California

G a s H e a t e d

Items	Per dry ton Maximum	Per dry ton Minimum	Per dry ton Average
Labor	2.12 hrs.	1.028 hrs.	\$.598 (cost)
Fuel	1.453 M.C.F.	.650 M.C.F.	\$.870 (cost)
Power	32.66 Kwh.	17.23 Kwh.	21.7 Kwh.
Dryaway	541.5 lbs.	161.7 lbs.	293.3 lbs.
Thermal Efficiency	34.3 %	11.9 %	22.55 %
Operating Costs	\$ 3.03	\$ 1.69	\$ 2.10
Plant Fixed Charge	\$ 7.97	\$ 4.33	\$ 6.82
Accessory Fixed Charge	\$ 2.00	\$.61	
Total cost per ton	\$ 13.00	\$ 6.63	\$ 8.92

O i l H e a t e d

Items	Per dry ton Maximum	Per dry ton Minimum	Per dry ton Average
Labor	2.195 hrs.	1.364 hrs.	\$.844 (cost)
Fuel	11.12 gals.	9.52 gals.	\$.804 (cost)
Power	16.24 Kwh.	14.11 Kwh.	18.30 Kwh.
Dryaway	536.5 lbs.	257.8 lbs.	362.8 lbs.
Thermal Efficiency	33.9 %	9.8 %	21.8 %
Operating Costs	\$ 1.97	\$ 1.90	\$ 1.93
Plant Fixed Charge	\$ 6.50	\$ 5.93	(\$ 6.90)
Accessory Fixed Charge	\$ 1.70	\$.24	(\$ 6.90)
Total cost per ton	\$ 10.17	\$ 8.07	\$ 8.83

WALNUT DEHYDRATION

Summary Cost Table Giving the Maximum, Minimum, and Average Value for Various Methods of Heating Walnut Dehydrators of the Rectification Type in California

Gas Heated

Items	Per dry ton Maximum	Per dry ton Minimum	Per dry ton Average
Labor	2.12 hrs.	1.028 hrs.	\$.588 (cost)
Fuel	1.453 M.C.F.	.680 M.C.F.	\$.870 (cost)
Power	32.88 Kwh.	17.23 Kwh.	21.7 Kwh.
Freight	\$41.5 lbs.	161.7 lbs.	223.3 lbs.
Thermal Efficiency	34.3 %	11.9 %	22.55 %
Operating Costs	\$ 3.03	\$ 1.69	\$ 2.10
Plant Fixed Charge	\$ 7.97	\$ 4.32	\$ 6.82
Necessary Fixed Charge	\$ 2.00	\$.81	
Total cost per ton	\$ 13.00	\$ 6.63	\$ 8.92

Oil Heated

Items	Per dry ton Maximum	Per dry ton Minimum	Per dry ton Average
Labor	2.195 hrs.	1.364 hrs.	\$.844 (cost)
Fuel	11.12 gals.	9.52 gals.	\$.804 (cost)
Power	16.24 Kwh.	14.11 Kwh.	18.30 Kwh.
Freight	\$36.5 lbs.	257.8 lbs.	222.8 lbs.
Thermal Efficiency	33.9 %	9.8 %	21.8 %
Operating Costs	\$ 1.97	\$ 1.90	\$ 1.93
Plant Fixed Charge	\$ 6.50	\$ 5.93	\$ 6.20
Necessary Fixed Charge	\$ 1.70	\$.24	
Total cost per ton	\$ 10.17	\$ 8.07	\$ 8.23

E l e c t r i c a l l y H e a t e d

<u>Items</u>	<u>Per dry ton</u> <u>Maximum</u>	<u>Per dry ton</u> <u>Minimum</u>	<u>Per dry ton</u> <u>Average</u>
Labor	5.662 hrs.	1.372 hrs.	\$ 1.377 (cost)
Fuel	335.4 Kwh.	60.6 Kwh.	1.65 (cost)
Power	48.62 Kwh.	24.33 Kwh.	31.8 Kwh.
Dryaway	321.2 lbs.	96.3 lbs.	209.4 lbs.
Thermal Efficiency	56.3 %	28.0 %	43.8 %
Operating Costs	\$ 4.05	\$ 2.80	\$ 3.36
Plant Fixed Charge	\$ 6.92	\$ 4.16	\$ 5.26*
Accessory Fixed Charge	(Included in fixed charges)		

Total cost per ton \$ 10.97 \$ 6.96 \$ 8.62

*Includes both accessory and plant fixed charges.

NOTE: The average cost for labor was 39.7¢ per hour; for fuel 71¢ M. cu. ft. of gas, 7¢ per gal. of fuel oil, and 1.04¢ per Kw. hr., and for power 2.14¢ per Kw. hr. The fixed charge is based on a plant cost of from \$1,050.00 to \$7,000.00, and the accessory fixed charge on an accessory cost of from \$100.00 to \$600.00. The \$7,000. dehydrators are electrically heated, the others costing materially less. The above charges do not include taxes, insurance, repairs, or superintendence.

There are some driers used which are not of the recirculating type, but since all the electrically heated driers are of this type, data from the recirculating type only are included.

Out of a total of 6,000 acres of walnuts in the State of Oregon in 1926, only three had forced draft dehydrators, natural draft being depended upon. However, it seems quite likely that within a very short time forced draft drying will become popular. Several are using their prune driers to dry walnuts, which represents quite a saving in overhead. In California, forced draft dehydrators are generally used and in a few cases the heating is done electrically. This is only made possible by the low percentage of moisture to be removed. English walnuts contain from 12 to 25% of moisture when wet, and around 8% when sufficiently dry. Furthermore, the electrically heated driers are about twice as efficient as the other types, the overall thermal efficiencies being around 44% as compared to 22%. This, of course, resulted in a more expensive drier, (\$5,500. as compared to \$2,500. on the average), but the cost per ton was actually lower due largely to the greater number of tons handled per drier---over 150 tons as compared to a

Electrically Heated

Items	Per dry ton Maximum	Per dry ton Minimum	Per dry ton Average
Labor	5.682 hrs.	1.372 hrs.	\$ 1.377
Fuel	335.4 Kwh.	60.6 Kwh.	1.85 (cost)
Power	46.62 Kwh.	24.38 Kwh.	31.8 (cost)
Dryway	321.2 lbs.	26.3 lbs.	208.4 lbs.
Thermal Efficiency	56.3 %	26.0 %	43.8 %
Operating Costs	\$ 4.05	\$ 2.80	\$ 3.36
Plant Fixed Charge	\$ 6.92	\$ 4.16	\$ 5.26*
Accessory Fixed Charge			
(Included in fixed charges)			
Total cost per ton	\$ 10.97	\$ 6.96	\$ 8.62

*Includes both accessory and plant fixed charges.

NOTE: The average cost for labor was 38.7¢ per hour; for fuel 1¢ M. on. ft. of gas, 7¢ per gal. of fuel oil, and 1.04¢ per Kw. hr., and for power 2.14¢ per Kw. hr. The fixed charge is based on a plant cost of from \$1,050.00 to \$7,000.00 and the accessory fixed charge on an accessory cost of from \$100.00 to \$800.00. The \$7,000.00 dryway is electrically heated, the others costing materially less. The above charges do not include taxes, insurance, repairs, or superintendence.

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little over 50 tons on the average. The dryaway for the electrically heated machines was also lower than for the other types in the above tests.

It seems quite obvious that the energy rate must be low if the electrically heated drier is to be practical; it was around 1¢ per Kw. hr. in California. Furthermore, it would seem essential that the transformers also be used for some other purpose, such as irrigation, so that the demand charge will not be excessive. The 1¢ per Kw. hr. in California covered the demand charge.

Energy Consumption

The energy consumption for power varied from 17.23 to 32.66 Kw. hrs. per dry ton, an average of 21.7 Kw. hrs. on the gas heated dehydrators; from 16.24 to 14.11 Kw. hrs. or an average of 18.30 Kw. hrs. on the oil heated dehydrators, and from 48.62 to 24.33 Kw. hrs. or an average of 31.8 Kw. hrs. on the electrically heated machines. It took from 60.6 to 335.4 Kw. hrs. or an average of 167 Kw. hrs. per ton of dried walnuts for heating on the electrically heated driers.

Thus each ordinary dehydrator will consume, on the average, about 1000 Kw. hrs. per season (20 Kw. hrs. per ton) on the basis of the California figures. Similarly, each electrically heated drier on the average will consume about 4500 Kw. hrs. per season (30 Kw. hrs. per ton) for power, and around 25,000 Kw. hrs. more for heating, (an average of 167 Kw. hrs. per ton) or about 30,000 Kw. hrs. all told. This gives a total consumption for the electrically heated plants of close to 200 Kw. hrs. per ton of dried walnuts.

The connected load for heating will average around 8 Kw. hrs. per ton of dry walnuts, (capacity), when the nuts are dried in bins. The connected load for the fan will vary from 1 to 3 H. P. per ton of dry walnuts.

It takes from 12 to 24 hrs. per dehydration, the season lasting about 3 weeks. In the larger driers, like the electrically heated Anderson, about 95% of the air is recirculated.

Conclusions

Even though the cost per ton of walnuts may be slightly higher with the

little over 50 tons on the average. The driveway for the electrically heated machines was also lower than for the other types in the above tests. It seems quite obvious that the energy rate must be low if the electric-

ally heated dryer is to be practical; it was around 14 per Kw. hr. in California. Furthermore, it would seem essential that the transformers also be used for some other purpose, such as irrigation, so that the demand charge will not be excessive. The 14 per Kw. hr. in California covered the demand charge.

Energy Consumption

The energy consumption for power varied from 17.23 to 32.66 Kw. hrs. per dry ton, an average of 21.7 Kw. hrs. on the gas heated dehydrators; from 18.24 to 44.11 Kw. hrs. or an average of 18.30 Kw. hrs. on the oil heated dehydrators, and from 48.62 to 24.53 Kw. hrs. or an average of 31.8 Kw. hrs. on the electrically heated machines. It took from 60.6 to 335.4 Kw. hrs. or an average of 167 Kw.

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Conclusions

Even though the cost per ton of walnuts may be slightly higher with the

electrically heated dehydrator as compared to other types, the former should eventually prove more popular because of its reliability, ease of operation, and automatic temperature control.

The prune, walnut, and hop driers, if developed together, should prove a far more attractive load to the power company than any one group, by itself, the prune drying in Oregon usually coming during the first three weeks of September, hop drying starting around the middle of September, and walnut drying around the first of October.

The use of prune driers by some growers for their walnut crop saves considerable overhead, of course, but the prune drier is not so very well adapted to walnut drying. For one thing, the temperature in a walnut dehydrator should not go above 112° F. whereas a prune drier is built for higher temperatures, 160° F. being the critical temperature. This, of course, affects the air flow and other features in the design.

GOOSEBERRY GRADING AND CLEANING

One Oregon farmer who has a considerable acreage of gooseberries, has rigged up a homemade gooseberry cleaner. Since the berries are merely stripped from the stems, a considerable amount of leaves and trash is left among them. As a usual thing the berries and trash are poured back and forth from one container to another until the wind has blown out the trash. This farmer fixed up an inclined table about 6 ft. long by 2 ft. wide with a screened opening part way down through which an air blast from a 4 in. fan operated by a 1/2 H. P. motor, was directed. The width of this opening could be varied by means of a sliding door so that the strength of the blast would be suitable to the berries going through.

The farmer also found that the light and wormy berries could be separated from the good ones by increasing the air velocity somewhat, and this year he plans on making some changes in his present machine so that these two operations

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can be done at the same time. The trash and wormy berries will be blown away, and the smaller ones merely blown to one side onto a shelf directly above the inclined table. The power consumption, of course, is negligible---10 Kw. hrs. for cleaning 6,900 lbs. of gooseberries.

If such a machine is developed and sold by some commercial concern it should be rather inexpensive and quite a boon to gooseberry growers.

BULB GRADING

The bulb growing industry has been increasing very rapidly in certain favored sections since the stoppage of foreign imports by the U. S. Department of Agriculture.

It takes three years to grow bulbs for the market and a great deal of time is spent in grading. To take care of this, Mr. Otto Reise of Puyallup, Washington, conceived the idea of grading his bulbs with a machine patterned after a potato grader, using $1/4$ H. P. motor and 4 screens with 1 in., $1-1/2$ in., 2 in. and $2-1/2$ in. openings respectively. One hundred seventy seven pounds of bulbs were graded in $6-1/2$ minutes and while the grading was not sufficient for marketing, (for instance, the mother bulbs with small bulbs attached going in with the large ones) it was satisfactory for those to be planted for the second and third season, and saved a great deal of time on even the marketable sizes. The energy consumption obviously is negligible.

Mr. Reise feels that he can well afford to do further investigating along this line but not necessarily with exactly the same type of machine.

Conclusion

A thoroughly reliable bulb grader will fill a real need among the growers, and its proper design would seem to be dependent merely upon careful experimentation and testing. It need not be expensive.

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ELECTRIC HEAT FOR YOUNG ANIMALS

Properly located electric heating units will materially lower the farmer's losses at farrowing and lambing time. It prevents chilling at this most critical time. One Kw. hr. of total capacity properly distributed should take care of a large, well insulated farrowing pen.

One Minnesota hog breeder increased his income by over \$600.00 through the use of electric heaters in his farrowing pens.

GARDEN TRACTOR

A practical small electric tractor would be a big boon to greenhouse growers and truck gardeners. Due mainly to transmission problems no such tractor so far has been developed. In New York they are working on a garden tractor operated by 1 H. P. motor which looks promising. A flexible cable is being used to transmit the power as it seems to be the only plausible method under field conditions that would be flexible and not too expensive. A progress report probably will not be available until late in the summer.

HEATING SOIL WITH ELECTRICITY

The following report has been submitted by the U. S. Consul General at Stockholm, Sweden.

During 1926 experiments have been carried on in Sweden to ascertain the advisability of heating soil with electricity.

Among the various investigations in progress may be mentioned one in connection with growing green produce on a farm in the vicinity of Stockholm where it has been found possible to have lettuce ready for sale in March, with future prospects of being able to modify the seasonal environment to such an extent that lettuce will be put on the Christmas market.

Preliminary Trials

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Preliminary Trials

The first attempt to warm soil with electricity was made with a current

of 5 to 25 volts sent through a lead wire, not insulated, which ran underneath the ground. This method was found to be impractical, however, due in part to the high costs of operation.

The next trial was made with a specially manufactured heating cable provided with armatures of special construction. In 1926 these devices were tried in six forcing beds in a market garden near Stockholm. Results of this attempt were quite satisfactory, it is said, and the owner of the place now has 1,300 square meters of forcing bed soil electrified in this way. Power is provided thru a specially constructed transformer which reduces the current from 3,000 volts to 127. The power is then distributed thru the beds where it warms the air underneath the glass as well as the soil.

Lettuce Set in February

In the latter part of February, 1927, 80,000 lettuce plants were set in the forcing beds of the market garden where the electrification experiments are in progress. It is anticipated that this lettuce will be ready for market by the first of April, a feat which could have been accomplished heretofore only in greenhouses. Electrification of the soil will revolutionize market gardening, at least as far as forcing plants for out-of-season markets is concerned, is the belief of the market gardener sponsoring the investigations.

Old and New Methods to be Compared

Market gardeners in the vicinity of Stockholm are said to be much interested in an experiment which will soon be started at the market garden in question, by which the investigator hopes to show definitely the differences between the method of heating the soil by manure and that of electrification. The object of the investigation is to show how many kilowatt hours the electrical method will take to produce the same temperature as is obtained thru manure heating, and also to compare differences in the crop, for it is said that electrical heating produces more plants due to the absence of ammonia gases and to better drainage in the soil.

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Experimentation in Norrland

In the far north of Sweden where there is plenty of sun in certain seasons of the year but where the soil is comparatively cold, considerable interest has been shown in the possibility of electrical heating of the soil. Trial beds have been set down in three localities.

Attempt to Warm Soil in Open Field

As reported from this office some time ago, agricultural experiment authorities at the Stockholm Agricultural Experiment Station will attempt to electrify soil in an open field having an area of 2,000 square meters, in which 110 electric wires set 40 meters apart will be used. It is hoped that potatoes may be planted in April in this field and harvested in the early part of June. What is needed, it is said, is a ground temperature to correspond to the comparatively high air temperature in the spring of the year.

Electric Light Also Used

Electric light is also used in combination with electric soil heating at the farm where electric experimentation with forcing bed soil is being conducted. It has been found that plants which have stored up assimilation products can do without sunlight and grow with electric light only.

Predict Decreased Importation

Importation of green produce into Sweden will be considerably diminished if the investigations in question result favorably, it is predicted. Prices of green vegetables - now quite high - would be reduced if the new methods came into general practice, it is thought.

ELECTRIC HOTBED

Manure suitable for making hotbeds is becoming increasingly difficult to get, and, of course, much higher priced. Electricity offers an economical substitute for this source of heat, according to some tests recently carried on in the State of Washington.

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Construction and Cost

The hotbed was made standard size, 6' x 3', and in the place of the usual load of manure a perforated floor was placed about 2" above the ground in the pit. On this floor were mounted 2 separately controlled coils of resistance wire on knobs, 100 and 50 watts respectively, or a total of 150 watts. Six ordinary plats of earth were placed above the coils on adequate supports. The electrical equipment including the homemade resistance, (made by winding resistance wire on ordinary steel stock, their natural elasticity separating the wires sufficiently, when released, to prevent any shorting of individual coils), and switches cost about \$3.50.

Energy Consumption

With the temperature outside averaging around 40°F. and the temperature inside the hotbed usually around 60°F. or 65°F., it cost, on the average, around 5¢ per day (3¢ per Kw. hr.) to operate the hotbed. A large portion of the time the cost was not over 2¢ per day, and with manure at \$3.00 per load, under Washington conditions, it did not cost very much more to heat the hotbed electrically than with manure since the latter is not effective longer than 6 or 8 weeks.

Results

The cabbage, cauliflower, and tomato plants in the electrically heated hotbed were fully as vigorous as those in the ordinary hotbed.

In colder climates the hotbed would need insulation around the outside in the shape of earth and straw, or its equivalent, just as in the case with manure heated hotbeds.

ELECTROCULTURE

In Indiana a device is being tried out which it is claimed has resulted in remarkable plant development in its vicinity, say within 20 ft. or so, as compared to the test plats. The device was designed and tested in France. It has been mounted on a 20 ft. pole in the grape vineyard at Lafayette. It is well

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ELECTROCULTURE

In Indiana a device is being tried out which it is claimed has resulted in remarkable plant development in its vicinity, say within 20 ft. or so, as compared to the rest of the field. The device was designed and tested in France. It has been mounted on a 20 ft. pole in the grape vineyard at Lafayette. It is well

grounded, and in theory the bushy projecting top of wires is supposed to gather electricity from the air and feed it to the roots. Production records are available for the vineyard during the last two or three years, and if the device does prove to materially increase production it will be of considerable commercial importance, as it should not be very expensive. The engineering department at Purdue expects to make some similar devices, incorporating the essential features in the design but minus some of the details, and test them out at the same time for comparison.

SHEEP SHEARING

Some very interesting tests have been made in Oregon in which sheep shearing with hand sheep shears or blades, with a 10-tooth Stewart hand power machine, and with a 13-tooth Stewart power clipper operated by a 1/2 H. P. motor, were compared. It required about 8 minutes on the average to shear a sheep by hand; two-thirds as long to shear one with the hand-operated machine, and only a little over one-half as long with the motor-driven machine. With labor at \$1.00 per hour and electricity at 10¢ per Kw. hr. it cost 8.09¢ to shear a sheep with the electric clipper; 10.25¢ with the hand power clipper, and 13.9¢ with the ordinary blade shears. Thus it is apparent that with a large flock of sheep a considerable saving can be effected through the use of an electric clipper.

The operator noticed that he was somewhat handicapped by the shorter shaft leading to the cutter on the hand power clipper. The uniform power of the electric clipper was a noticeable advantage.

WOOD SAWING

There are many sections, especially in the East, where the farmer with a woodlot who has any spare time can very profitably spend it getting wood ready to sell. It will often bring two or three times as much as it is worth for heating or cooking, many farmers selling their firewood to people in the city who have

grounded, and in theory the busy projecting top of wires is supposed to gather electricity from the air and feed it to the roots. Production records are available for the vineyard during the last two or three years, and if the device does prove to materially increase production it will be of considerable commercial importance, as it should not be very expensive. The engineering department at Purdue expects to make some similar devices, incorporating the essential features in the design but minus some of the details, and test them out at the same time for comparison.

SHEEP SHEARING

Some very interesting tests have been made in Oregon in which sheep shearing with hand sheep shears or blades, with a 10-tooth Stewart hand power machine, and with a 12-tooth Stewart power clipper operated by a $1\frac{1}{2}$ H. P. motor, were compared. It required about 8 minutes on the average to shear a sheep by hand; two-thirds as long to shear one with the hand-operated machine, and only a little over one-half as long with the motor-driven machine. With labor at \$1.00 per hour and electricity at 10¢ per Kw. hr. it cost 8.03¢ to shear a sheep with the electric clipper; 10.25¢ with the hand power clipper, and 13.9¢ with the ordinary blade shears. Thus it is apparent that with a large flock of sheep a considerable saving can be effected through the use of an electric clipper. The operator noticed that he was somewhat handicapped by the shorter shaft leading to the cutter on the hand power clipper. The uniform power of the electric clipper was a noticeable advantage.

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fireplaces, and then doing their cooking with electricity instead of wood.

The electric motor furnishes a motive power which is reliable and absolutely independent of temperature conditions---quite an important consideration at the time of year when wood is generally cut.

Energy Consumption

Generally it will take about 2.4 Kw. hrs. to cut a cord of wood into 12" lengths, according to some figures from Wisconsin. If the wood is cut into 18" lengths it will take only about 1.1 Kw. hrs. per cord of ordinary wood, according to some tests made by the Adirondack Power & Light Corporation at Schenectady, New York. The consumption, of course, is quite variable, depending upon the size and condition of the wood as well as the lengths into which it is cut. For example, it took 5.7 Kw. hrs. per cord to cut some large green poles into 16" lengths, according to a report from Wisconsin.

CONCRETE MIXING

A concrete mixer is widely appreciated as a great labor saver, and the electric motor furnishes an ideal motive power for the machines commonly used on the farm. One-half H. P. will easily handle the average small batch mixer. According to some data from Wisconsin, it will take from .4 to .5 Kw. hrs. to mix a cubic yard of concrete, it taking more energy with finer "aggregate".

PAINT SPRAYING

Seven times as much area can be covered by an experienced operator with a good spray gun as compared to the work done by a good painter with a hand brush---that is, within a given length of time. There is no more paint loss with modern guns than with hand brushes. By using a guard, trim can be added and the painting done so well in general that little retouching with the hand brush will be necessary.

A good paint spraying machine in the hands of an experienced operator

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has a capacity of about 800 sq. ft. of straight wall surface per hour, and in that hour would consume from 1 to 1-1/2 Kw. hrs., depending upon whether it is operated by a 1 or a 1-1/2 H. P. motor.

General Conclusions

The greatest deterrent to the more general use of paint spraying machinery is undoubtedly its high first cost, a good machine costing from \$300.00 to \$450.00. Good machines are manufactured by the DeVilbiss Manufacturing Company of Toledo, Ohio, and by the Binks Spray Equipment Company, 3114-28 Carroll Avenue, Chicago, Illinois. Because of this high first cost and the fact that farm buildings are not painted, on the average, more than once every three or four years, and, furthermore, that it requires experience to operate and properly care for a machine, their operation will likely be confined almost entirely to custom work.

A Mr. Warren of Hurley, New York, has a homemade outfit consisting of a 4 cu. ft. air pump, 30 gallon air tank, 1 H. P. motor, 2 quart gun, and 40 or 50 feet of air hose mounted on a portable truck, which has proven very satisfactory. By using a 1/32" nozzle and air at a pressure of 160 lbs. he has been able to easily remove whitewash. The outfit is also used to pump up the automobile tires.

In New York State there is considerable interest in the possibilities of developing a smaller homemade outfit consisting of a pump such as a No. 1 Brown & Sharpe gear pump with 1/2" pipe connections, operated by a 1/4 H. P. motor, and other paraphernalia. The pressure would be regulated by a by-pass pipe with a valve so that the paint would be recirculated in the open paint bucket, this keeping the paint agitated and preventing excessive overloads on the motor. There would be, of course, no air pressure tank. If such an outfit should prove practical it might be feasible for each farmer to own his own outfit. It could be used, also, for disinfecting and whitewashing.

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Research Council, the Dunning Compressor Company of Holmesburgh, Philadelphia, now list a small paint sprayer complete with a 1-1/4 cu. ft. compressor and 1/4 H. P. motor but without a tank, at \$75.00.

THRESHING

The electric motor, due to its unvarying speed, offers a very satisfactory motive power for threshing machines. The load, of course, is somewhat seasonal. However, in the South it is more desirable than the ginning load, due to the smaller motors (7-1/2 H. P.) used on the small hand-feed machines commonly used, and, furthermore, it comes before the ginning load.

Where there is danger of low voltage it is probably better to have the main part of the thresher driven by a separate motor so that "slugs" will not slow down the other parts of the machine and cause higher grain losses. In Minnesota a 15 H. P. motor was replaced by 3 motors: a 10 H. P. on the main part, a 3 H. P. on the fan, and a 1-1/2 H. P. variable speed motor on the shoe or shaker. In another case a Washington farmer has a 20 H. P. motor on the main part of his clover huller, and a 2 H. P. on a fan for blowing the chaff and fine leaves onto a separate pile. However, the huller requires only around 13 H. P. at full load, both motors.

The electric motor is not well adapted to starting threshing machines as it gets up to speed in entirely too short a time. This results in excessive belt slippage, especially with the small drive pulleys required on the ordinary standard motor. A starting compensator which would remedy these starting troubles is considered too expensive by most farmers or custom threshers.

Energy Consumption

With a small thresher (7-1/2 H. P. to operate) it took 26 Kw. hrs. per 100 bushels threshed, mostly oats, according to some figures from Alabama.

In a typical case where a large machine was being used (Minnesota) it took about .25 Kw. hrs. per 100 lbs. of grain or 9 Kw. hrs. per 100 bushels of

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Where there is danger of low voltage it is probably better to have the main part of the thrasher driven by a separate motor so that "slugs" will not slow down the other parts of the machine and cause higher grain losses. In Minnesota a 15 H. P. motor was replaced by 3 motors: a 10 H. P. on the main part, a 3 H. P. on the fan, and a 1-1/2 H. P. variable speed motor on the shoe or shaker. In another case a Washington farmer has a 20 H. P. motor on the main part of his clover huller, and a 2 H. P. on a fan for blowing the chaff and fine leaves onto a separate pile. However, the huller requires only around 15 H. P. at full load, both motors.

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Energy Consumption

With a small thrasher (7-1/2 H. P. to operate) it took 28 Kw. hrs. per 100 bushels thrashed, mostly oats, according to some figures from Alabama. In a typical case where a large machine was being used (Minnesota) it took about 25 Kw. hrs. per 100 lbs. of grain or 9 Kw. hrs. per 100 bushels of

oats and 8 Kw. hrs. per 100 bushels of succotash threshed.

HYDRO-ELECTRIC PLANTS

In isolated localities which are fortunate enough to have water power in some form or other a small hydro-electric plant will often furnish one or more farmers with many of the conveniences and comforts of central station service. These plants will usually cost from a little less than \$200.00 up to several thousands, depending upon the physical condition and the size of the installation. The operating costs are low but usually there are one or more months during the summer when little or no power is available. Where power company service is not available the small hydro plant will continue to be a real factor in improving rural living conditions.

A survey of small water power plants has been made in both Washington and Oregon and a general bulletin on the subject has been published by the U. S. Department of Agriculture at Washington, D. C.

INDIVIDUAL LIGHTING PLANTS Engine Driven

B a t t e r y T y p e

Missouri

Wisconsin

Virginia

Cost of Plant	\$648.86	\$ 450.00	
Cost, including Wiring			\$602.46
Cost, including			
Wiring and Fixtures	790.99		
Fuel and Oil	17.87	34.00	73.45
Repairs	6.34	3.54	4.66
Labor	9.35	8.50	7.94
Annual Operating			
Cost	33.56	46.04	86.05
Interest		13.50	18.07
Depreciation		62.50	75.24
Taxes and Insurance		4.40	
Annual Overhead Cost		80.40	93.31
Annual Total Cost		126.44	179.36

All of the above are based on estimates by plant owners.

costs and 8 Kw. hrs. per 100 bushels of sweetpotatoes threshed.

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INDIVIDUAL LIGHTING PLANTS Engine Driven

Battery Type

<u>Missouri</u>	<u>Wisconsin</u>	<u>Virginia</u>
Cost of Plant	\$450.00	\$602.48
Cost, including Wiring		
Cost, including		
Wiring and Fixtures		
780.92		
Fuel and Oil	34.00	73.48
Repairs	8.54	4.88
Labor	8.50	7.94
Annual Operating		
Cost	46.04	86.08
Interest	13.50	18.07
Depreciation	62.50	75.24
Taxes and Insurance	4.40	
Annual Overhead Cost	80.40	92.31
Annual Total Cost	126.44	172.38

Non - Battery TypeVirginia

Cost including Wiring	\$577.22
Fuel and Oil	69.73
Repairs	.28
Labor	5.00
Annual Operating Cost	75.01
Interest	17.31
Depreciation	57.72
Annual Overhead Cost	75.03
Annual Total Cost	150.04

On an estimated basis of 360 Kw. hrs. per year the Wisconsin figures give a cost of 35 cents per Kw. hr.

Estimating that the average use in Virginia was 600 Kw. hrs. per year, which is probably high, the cost per Kw. hr. would be 30 cents for the battery type plants and 25 cents for the non-battery type plants.

It is worthy of note that it costs the farmers in Wisconsin an average of about \$10.50 per month to have an individual plant service, and in Virginia, an average of about \$15.00 per month to have the battery type of plant service, and about \$12.50 for non-battery plant service.

NEBRASKA DATA

	<u>Battery Plants</u>		<u>Non-Battery Plant</u>
Size	800 watts	1250 watts	1500 watts
Kw. hrs. per month	28	70	46
Fuel and Oil per Kw. hr.	17¢	8.3¢	14.4¢
Fixed charges per Kw. hr.	29¢	14.3¢	15.0¢
Total Cost per Kw. hr.	46¢	22.6¢	29.4¢
Fuel	Gasoline	Kerosene	Gasoline

In Illinois tests were made on five battery plants in use on farms.

Annual ConsumptionCost per Kw. hr.

120 Kw. hr.	\$0.63
360 Kw. hr.	\$0.34
1200 Kw. hr.	\$0.188

Life of Battery

<u>State</u>	<u>No. of years</u>
Missouri	5.2
Virginia	6.5
Wisconsin	5.0

All of the above are based on estimates by plant users.

Non-Battery TypeVirginia

\$277.22
69.78
28.
6.00
75.01
17.31
87.72
75.03
150.04

Cost Including Wiring
Fuel and Oil
Repairs
Labor
Annual Operating Cost
Interest
Depreciation
Annual Overhead Cost
Annual Total Cost

On an estimated basis of 360 Kw. hrs. per year the Wisconsin figures give a cost of 35 cents per Kw. hr. Estimating that the average use in Virginia was 600 Kw. hrs. per year, which is probably high, the cost per Kw. hr. would be 30 cents for the battery type plants and 25 cents for the non-battery type plants. It is worthy of note that it costs the farmers in Wisconsin an average of about \$10.50 per month to have an individual plant service, and in Virginia, an average of about \$15.00 per month to have the battery type of plant service, and about \$12.50 for non-battery plant service.

NEBRASKA DATANon-Battery PlantBattery Plants

1500 watts
48
14.44
16.04
29.44
Gasoline

1250 watts
70
8.34
14.34
22.64
Kerosene

800 watts
28
174
294
464
Gasoline

Size
Kw. hrs. per month
Fuel and Oil per Kw. hr.
Fixed charges per Kw. hr.
Total Cost per Kw. hr.
Fuel

In Illinois tests were made on five battery plants in use on farms.

Cost per Kw. hr.Annual Consumption

\$0.63
\$0.34
\$0.188

120 Kw. hr.
360 Kw. hr.
1200 Kw. hr.

Life of BatteryNo. of yearsState

Missouri 5.2
Virginia 6.5
Wisconsin 6.0

All of the above are based on estimates by plant users.

The Figures Give the Percentage of Total Number of Farmers Having Individual Plants Which are Being Used for the Items Indicated

Uses	BATTERY PLANTS			NON-BATTERY PLANTS
	Missouri	Wisconsin	Virginia	Virginia
Battery Charger	.69%			
Cabinet				5.5 %
Churn			8.9 %	
Clippers		9.1 %		
Corn Sheller		4.5 %	.63%	
Curling Iron			1.9 %	
Drill Press		4.5 %		
Fans	8.3 %	18.2 %	7.6 %	11.1 %
Fanning Mill		9.1 %	.63%	
Grindstone	.69%	31.8 %		
Heaters			.63%	
Heating Pads	.69%	4.5 %		
Irons	67.3 %	63.7 %	24.8 %	50.0 %
Lights	100.0 %	100.0 %	100.0 %	100.0 %
Meat Grinder			.63%	
Milking Machine	.69%	9.1 %		
Motors	6.2 %		3.1 %	5.5 %
Phonographs			.63%	
Percolators			1.2 %	5.5 %
Pumps	16.6 %	36.3 %	28.0 %	22.2 %
Radio	1.3 %		1.2 %	
Refrigerator	.69%		1.2 %	
Separator	7.6 %	41.0 %	2.5 %	
Stove				11.1 %
Toaster		4.5 %	1.9 %	5.5 %
Vacuum Cleaner	33.3 %	13.6 %	8.9 %	16.6 %
Washing Machine	41.6 %	68.2 %	11.4 %	16.6 %

While the data presented are typical they may well be compared with and more extensive tables made from other available data. The above compilations were made from the following:

Bulletin 243 Farm Lighting Systems, by M. M. Jones
Published November 1926 by University of Missouri
Agricultural Experiment Station, Columbia, Missouri.

Circular 163 Turn On The Light, published July, 1923
by Extension Service of the College of Agriculture,
University of Wisconsin, Madison, Wisconsin.

Vol. II, No. 6, C. R. E. A. Bulletin, May 1926.
"Rural Electrification in Virginia" by D. C. Heitshu

During the past year it appears that the small non-battery plant has been growing in popularity.

The figures give the percentage of total number of farmers having individual plants which are being used for the items indicated

NON-BATTERY PLANTS

BATTERY PLANTS

Uses	Missouri	Wisconsin	Virginia	Virginia
Washing Machine	41.8%	68.2%	11.4%	16.8%
Vacuum Cleaner	33.3%	13.6%	8.9%	16.8%
Toaster		4.5%	1.9%	5.5%
Stove				11.1%
Separator	7.6%	41.0%	2.6%	
Refrigerator	6.9%		1.3%	
Radio	1.3%		1.3%	
Pumps	16.6%	36.3%	28.0%	22.2%
Percolators			1.3%	5.5%
Phonographs	6.2%		3.1%	5.5%
Motors		9.1%		
Milking Machine	6.9%			
Meat Grinder			6.9%	
Lights	100.0%	100.0%	100.0%	100.0%
Iron	67.3%	83.7%	24.8%	50.0%
Heating Pads	6.9%	4.5%		
Heaters			6.9%	
Grindstone	6.9%	21.8%	9.1%	
Penning Mill		18.2%	7.6%	11.1%
Pans	9.3%			
Drill Press		4.5%		
Curling Iron			1.9%	
Corn Sheller		4.5%	6.9%	
Choppers		9.1%	8.9%	
Churn				
Cabinet				5.5%
Battery Charger	6.9%			

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WIND DRIVEN INDIVIDUAL LIGHTING PLANTS

Some work on the wind driven individual lighting plant has been done in Indiana, Illinois, Iowa, Minnesota, and Nebraska but the only data available are from the Nebraska project.

In this case a 10' aeroplane-type propeller was mounted on a 60' tower. The generator, also mounted on the tower, was of 1.K. W. capacity, 110 volt, and differentially-compound wound. A load of lamps arranged to use approximately 1 Kw. hr. per day was used. During the year 730 Kw. hrs. were generated and 309 Kw. hrs. used from the battery. During 55 days, mostly in July, August, and September, the battery voltage was so low that the lights could not be turned on without damaging the battery. The generator started charging the battery where a wind velocity of 10 miles per hour was reached, and reached full charging capacity with a wind velocity of 25 miles per hour. The average cost of current was 35¢ per Kw. hr.

It is reported that a recent development of the wind electric plant involves the use of two propellers with a promise of somewhat increased capacity and efficiency.

RURAL INDUSTRIES AND INSTITUTIONS

There are a great many rural industries which are dependent upon, or at least their operating conditions are improved, by electric power.

(a) Rural Church and School

In the modern rural school, church, and parsonage electric light and power are a necessity. Along this line it is interesting to note that electric heat is one of the important factors in the rapid extension of the hot lunch at school.

(b) Cheese Factory and Creamery

In the cheese factory and creamery electric motors operate agitators, curd cutters, band saws for making cheese boxes, hoists for bringing the cheese

WIND DRIVEN INDIVIDUAL LIGHTING PLANTS

Some work on the wind driven individual lighting plant has been done in Indiana, Illinois, Iowa, Minnesota, and Nebraska but the only data available are from the Nebraska project.

In this case a 10' aeroplane-type propeller was mounted on a 60' tower. The generator, also mounted on the tower, was of 1-K.W. capacity, 110 volt, and differentially-compound wound. A load of lamps arranged to use approximately 1 Kw. hr. per day was used. During the year 730 Kw. hrs. were generated and 309 Kw. hrs. used from the battery. During 55 days, mostly in July, August, and September, the battery voltage was so low that the lights could not be turned on without damaging the battery. The generator started charging the battery where a wind velocity of 10 miles per hour was reached, and reached full charging capacity with a wind velocity of 25 miles per hour. The average cost of current was 35¢ per Kw. hr.

It is reported that a recent development of the wind electric plant involves the use of two propellers with a promise of somewhat increased capacity and efficiency.

RURAL INDUSTRIES AND INSTITUTIONS

There are a great many rural industries which are dependent upon, or at least their operating conditions are improved, by electric power.

(a) Rural Church and School

In the modern rural school, church, and parsonage electric light and power are a necessity. Along this line it is interesting to note that electric heat is one of the important factors in the rapid extension of the hot lunch at school.

(b) Cheese Factory and Creamery

In the cheese factory and creamery electric motors operate agitators, curd cutters, band saws for making cheese boxes, hoists for bringing the cheese

from the airing cellar, milk pumps, milk bottlers, milk and can washers, butter workers and churns, heat cheese starter boxes, etc.

(c) Country Store

The country store finds the use of electricity for ice cream cabinets and other refrigeration jobs, for grinding coffee, lighting, etc. of very great importance.

(d) Mills

Many country mills, some of them well established institutions, find electric power an important feature of economical operation. Among these are mustard, horseradish, cider, and grist mills, the latter having an energy consumption of around 1 Kw. hr. per bushel of meal ground. There are also many canning factories which could very profitably use electric power.

(e) Greenhouses

In the rural greenhouse electricity is very helpful in raising the windows (either automatic or manual control), furnishing water under pressure, furnishing supplementary light, heating hotbeds, etc.

(f) Pea Vining

In Wisconsin electricity has proven somewhat cheaper and considerably more reliable than other commonly used sources of power for pea vining and shelling.

Energy Consumption and Power Required

Twenty H. P. motors are generally used, and it took around 4 Kw. hrs. per 100 lbs. of shelled peas in 1926, the total consumption per plant per season ranging from 2,751 Kw. hrs. to 3,145 Kw. hrs. The season lasts from around the middle of June to the last week in July. The load, though seasonal, is usually a daylight to dark proposition and therefore should be quite profitable for the power companies where the power lines are large enough to handle the energy requirements.

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daylight to dark proposition and therefore should be quite profitable for the
power companies where the power lines are large enough to handle the energy re-

quirements.

(g) Cotton Gin

From the standpoint of gin operation, electric drive is entirely satisfactory, but from the standpoint of the electric light and power company furnishing the services, the load is not particularly desirable. Three-phase service is required and the season for operation extends from September 1 to January 1 with a peak load in October. Therefore the power demand is relatively high and the season of operation relatively short.

Approximately .3 H. P. per saw is required for gin operation. On the basis of the records from 6 electrified gins operated in Alabama, handling a total of approximately 10,000 500-lb. bales of cotton, it required 16.67 Kw. hrs. per bale for ginning and pressing.

There is a possibility that a small gin which could be operated by a 5 H. P. motor would be useful under certain conditions. So far as is known there has been no investigation work on this possibility.

SEED GERMINATION

In Illinois a man who does custom seed corn testing has a large electrically heated and lighted seed germinator with a capacity of 1600 ears. The germinator is heated by two 100 watt and two 150 watt lamps, and consumed about 35 Kw. hrs. per week or run. The box is well insulated and the temperature is kept at 80° F. The kernels are laid on muslin on top of wet sawdust and the humidity is kept high by open pans of water just above the lights.

Considerable trouble was experienced through the burning out of the lights. It is probable that standard resistances of proper size and with Edison bases would have been satisfactory.

LINE AND TRANSFORMER LOSSES

Where the use of electricity ranges from 20 to 30 Kw. hrs. per farm per month, the line and transformer losses are often equal to or greater than the

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LINE AND TRANSFORMER LOSSES

Where the use of electricity ranges from 20 to 30 Kw. hrs. per farm per month, the line and transformer losses are often equal to or greater than the

amount of current used on the farms. In these cases only 50% or less of the energy fed to the rural line is recorded on the customers' meters.

Contrasted to this is the yearly average line efficiency of 88% obtained on the Red Wing line where the average monthly use was 250 Kw. hrs. per customer. This indicates that as the load builds up the line efficiency improves. It is worthy of note that the results on the Red Wing line also would seem to indicate that on a group of farm lines the demand factor can safely be taken as 15 or more---that is $1/15$ of the total connected load. Furthermore, it seems quite probable that well developed farm lines will have load factors of 30% or more.

TRANSFORMER LOADING AND LOCATION

On the Garner project a 1.5 Kva transformer was been carrying a connected load of 12 K. W. The largest piece of equipment connected was a 6 K. W. range. On a 15-minute test with a 4 K. W. load there was a drop of 11 volts but not a serious rise in the temperature of the cooling oil. This would indicate that voltage regulation is more important than temperature control for farm transformers where there may be a high maximum load of short duration. From these tests it seems probable that the demand factor of a farm may be taken as 10 instead of the commonly accepted 5, that is, with proper fusing and general protection of motors and devices. The subject needs further investigation.

On the Red Wing project the connected load for 3 Kva transformers ranges from 15.9 K. W. to 23.4 K. W. The highest recorded load carried on a 3 Kva transformer is 7.9 K. W. There is no report of the length of time of this load.

In Wisconsin some work has been done on this subject but data are not yet available. It is reported, however, that the tests indicate the possibility of carrying a farm connected load of from 8 to 10 times the rated size of the transformer.

This subject merits further investigation.

While no reports are available on the subject of transformer location,

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TRANSFORMER LOADING AND LOCATION

On the Garner project a 1.5 Kva transformer was been carrying a connected load of 12 K. W. The largest piece of equipment connected was a 8 K. W. range. On a 15-minute test with a 4 K. W. load there was a drop of 11 volts but not a serious rise in the temperature of the cooling oil. This would indicate that voltage regulation is more important than temperature control for farm transformers where there may be a high maximum load of short duration. From these tests it seems probable that the demand factor of a farm may be taken as 10 instead of the commonly accepted 8, that is, with proper fusing and general protection of motors and devices. The subject needs further investigation.

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This subject merits further investigation.

While no reports are available on the subject of transformer location,

it is evident from field experience that to reduce losses and maintain voltage the transformer should be located as near as possible to the center of the load. This subject also merits further investigation.

MAXIMUM DEMANDS OF RURAL LINES

<u>State</u>	<u>Number of Customers on line</u>	<u>Connected Load</u>	<u>Maximum Demand</u>
Alabama	89	83 K.W.	24 K.W.
Alabama	96	88 K.W.	22 K.W.
South Dakota	17	85.8 K.W.	15.5 K.W.
Minnesota	11	187.6 K.W.	22.8 K.W.

When a 15 H. P. motor was used for threshing in Minnesota, making a total connected load of 202.6 K.W., the maximum demand was 33.6 K.W.

When a 15 H. P. motor was used in Minnesota for husking corn, making a total connected load of 202.6 K.W., the maximum demand was 27.6 K.W. When a 7.5 H. P. motor was used for husking corn, making a total connected load of 195.1 K.W., the maximum demand was 29.4 K.W.

Undoubtedly the ratio of maximum demand to connected load will vary with the number of customers, size of connected load, Kw. hrs. used per month, and type of farming.

We have just enough information on this subject to indicate that it needs further study.

ONTARIO DATA BY STEWART

<u>District</u>	<u>Consumers</u>	<u>Peak Load October 1924</u>	<u>Peak Load Per Customer</u>
Woodstock	263	117.4 K.W.	.44 K.W.
Dorchester	240	70.9 K.W.	.29 K.W.
Preston	254	148.6 K.W.	.58 K.W.
Baden	37	24.6 K.W.	.66 K.W.
Galt	27	26.7 K.W.	.99 K.W.

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When a 15 H. P. motor was used in Minnesota for husking corn, making a total connected load of 202.8 K.W., the maximum demand was 27.8 K.W. When a 7.5 H. P. motor was used for husking corn, making a total connected load of 195.1 K.W., the maximum demand was 29.4 K.W.

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District	Customers	Peak load October 1924	Peak load Per Customer
Woodstock	283	117.4 K.W.	.44 K.W.
Dorchester	240	70.9 K.W.	.29 K.W.
Preston	264	148.8 K.W.	.48 K.W.
Eden	37	84.8 K.W.	.68 K.W.
Galt	27	28.7 K.W.	.98 K.W.

MILK PASTEURIZATION WITH ELECTRICITY

A large Pittsburgh dairy and ice cream plant has found another practical use for electricity, according to an article in the Electrical World for April 30, 1927. This so-called "Electropure" process has only recently been perfected. Its chief advantage as compared to the steam process which it replaced is its compactness. It greatly increased the capacity of the plant per square foot of floor area and decreased accordingly the labor of cleaning and sterilizing. This company estimates that it could afford to pay a total of three times as much for energy as it formerly paid for coal to do its pasteurizing.

According to a report made by the New York State Rural Electrification Research Council, with steam at \$1.00 per 1000 lbs. and electricity at 2¢ per Kw. hr., it cost \$.45 and \$2.65 respectively per 1000 gals. for heat. This is \$1.00 higher for the electric process than the figures in the Electrical World would lead one to expect.

According to the above company, the cost has not been so very much greater than the former cost of coal. The milk has a better flavor and cream line than is commonly the case with other processes.

The outfit consists of a 50 K.W. heater with water cooled carbon electrodes 3" apart, the milk acting as the conductor, together with the cooler, filter, surge tank, and milk pump. The pasteurizer has a capacity of 600 gals. per hour, and 1 Kw. hr. will pasteurize 12 gals. of milk. It takes 12 seconds on the average for the milk to flow through heater, the temperature being kept at 162°F. by regulating the speed of the milk pump. The pasteurized milk in flowing over the cooler preheats the milk flowing through the inside upper half of cooler on its way to the heater and is then further cooled ready for bottling by brine in the lower half of the cooler.

According to the report from a committee appointed by the Secretary of

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Health of Pennsylvania, there is still some question as to the sterilizing efficiency of the Electropure Process. Twenty-six per cent of the guinea pigs fed tuberculin milk treated at 155°F. became infected with tuberculosis. However, this is 7°F. lower than the present treating temperature.	
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Health of Pennsylvania, there is still some question as to the sterilizing efficiency of the Electropure Process. Twenty-six per cent of the guinea pigs fed

tuberculin milk treated at 185° F. became infected with tuberculosis. However,

this is 7% lower than the present freezing temperature.

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